INTERNATIONAL SEMINAR
ON
PLACER DEPOSITS

14-20TH DECEMBER, 1999

Abstract Volume

Sponsored by
OCEAN SCIENCE & TECHNOLOGY CELL (OSTC)
Department of Ocean Development, New Delhi.

Organised by
Department of Earth Sciences
Tamil University
Thanjavur - 613 005.
India.

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PREFACE

In the wake of dwindling natural resources, placer minerals exploration and exploitation is likely to be the agenda in the next millennium. Placer mining is not the recent development. Probably, the earliest mining for the human race, even before the civilization started, was the alluvial placer mining but only by crude methods. India, having a coastal strip of 6500 km with rich potential of placer sands primarily of monazite, garnet, ilmenite, kyanite, zircon, sillimanite and magnetite, is previleged to be proud of its mineral wealth. Though exploitation of these minerals is carried out manually, both in river bed and beach, the study on the mining aspects of placer sands visa vis environmental impacts have not been given any importance in our country. With the distribution of 0.22 % of zircon by weight, Australians are optimizing the profitability of placer minerals. 3 % ilmenite concentration at a depth of 30 to 40 m in African countries has been brought out as a potential site for ilmenite by Germans. When such low percentages are considered to be a profitable one, in our country the entire coastal stretch must be considered as a potential belt. With the scattered results available from the vast Quaternaries, the entire Quaternary sediments of this country can also be added up to the resourceful deposits for placers.

Exploratory efforts by the National Institute of Oceanography, Goa and other national agencies have proved the extensive presence of nearshore ilmenite - magnetite deposits. So far no effort has been taken for exploitation of the same. Under the existing technical know-how prevailing in the country, nearshore exploitation is still an elusive dream, though many countries are able to exploit the shelf particularly, for the bulk minerals profitably. As they have achieved success even in the middle shelf, such an approach and technical know-how in lifting the placer sand may not be a difficult task, for our industrialists, if they are prepared to venture. In case, we are able have a break through in exploiting nearshore/ innershelf placer minerals all along the coast, by liberalising the regulations applied by many national agencies on the mineral exploitation, it is going to be highly lucrative one in the 21st century. In order to draw more foreign investments and higher export revenue in this mining industry, the exploitation of placer minerals has to be carried out in the beach, inland and offshore.

It is necessary that the coastal mining has to be carried out with the environmental safety. However, wherever the mining operations and processing methods have to be activated, it may be highly necessary to liberalise the conditions in leasing out the areas. The strict vigilance of the Government Agencies can be enforced in promulgating the safety measures to protect the environment and exploitation of the society, keeping in mind in priority, the sustainable growth of the mineral industry in this country in the next millennium.

Having understood the lack of initiation in the higher education sector to give thrust to the most needed field of interest in this country not only for earning revenue, that too, in the form of foreign exchange but also to develop economically well placed coastal community , Secretary, Department of Ocean Development has chosen the most important and urgent necessity in exploring and exploiting the ocean wealth a field for which every one of us assembling here is interested. Tamilnadu being the state with rich potential of placer minerals, the establishment of Ocean Science and Technology Cell (OSTC) for beach placers here, will be of great use to many industrialists involved in the exploration of placers. It is really a well thought decision of the Secretary, Dr.A.E.Muthunayagam, Department of Ocean Development (DOD), Government of India, New Delhi to take the country well ahead to the next millennium.

After the inauguration of OSTC on placers, the Management Board has decided to go first for a seminar to take the global status in the research and development of placer minerals. The OSTC has come forward to project the following aims:

a. Exploration of non-living resources along the beaches,
b. Evaluation of beach placers and their economic viability of mining,
c. Mining the placers without coastal hazards,
d. Development of technology of exploitation of low grade placers,
e. Development of technology of low cost mining and
f. Manpower build up.

This cell is now exploring the possibility of encouraging the youth in the country to the research and development on placer studies, not only by giving the projects but also extending the proposed infrastructural facilities so as to take the Cell to be an advanced centre as well as to be a nodal centre for placer mineral research in the country.

The main thrust of the centre is to extend the field of research both to the basic research, and to the application of this research to the advancement of technology as well as to the coordination of industrialists.

This seminar is in the right direction of the approach. One can find the presence of all the leading industrialists of the placer minerals, as sponsorers as well as the participants to share their research and the experience to the delegates. It is a welcome sign for this OSTC to get a leap forward in its ambition and also to fulfil the expectations of the Secretary, DOD.

I am sure the OSTC will come forward to interact with industrialists in solving their problems particularly in the environment and to remain as a bridge with Government, in such a way to establish a sustainable development along the coast of this country.

It is our desire to have such seminar, workshop and trainings very often. OSTC is keen to develop scientific manpower so as to feed the needs of the industrialists who are badly in search of trained technical manpower in the field of exploration and exploitation of placer minerals. With the encouragement given presently by the Exporters of sands, I am sure it will be achieved.

For this seminar, I thank the Secretary Dr.A.E.Muthunayagam, DOD, for having given necessary approval to organise a seminar in a short notice. I am grateful to our Managing Board who has come forward to stand behind me and extend full support in all aspects of this OSTC. I am thankful to our Vice-Chancellor, Dr.C.K.Mahadevan, for his unconditional support in our OSTC activities and the growth of this centre. I am thankful to Dr.T.K.Mukherjee, Chairman and Managing Director, IRE, Mumbai for having come forward to deliver a special address entitled, "Exploitation of Heavy Mineral Resources", in this gathering in a very short notice. Dr.D.Jayakumar, Vice-Chancellor, Periyar University, Salem, who has given me encouragement and moral booster not only for this seminar but also for providing us the necessary spirit to conduct the research and for his inaugural address. I am highly thankful to Indian National Science Academy (INSA), New Delhi, who have come forward to strengthen this seminar with necessary financial support. I am much obliged to Dr.R.Srinivasan, Managing Director, Transworld Garnet India Pvt. Ltd., Chennai, for having come forward to provide the sponsorship for this seminar to depute his staff for the session and also to trigger the initiation to bring other Exporters in this programme.

I am thankful to Shri. Dhaya Devadas, Managing Director, Indian Garnet Sand Co. (P) Ltd., Chennai, who stood behind us in sponsoring this seminar from the beginning as well as depute their staff for presenting the articles. I am grateful to Mr.V.Vaikundarajan, Managing Director, V.V.Minerals, Tisayanvilai, for his keen interest in the participation and for the speedy action in sponsoring financial support as well as communicating the full paper and deputing his staff members to this seminar. I am thankful to Mr.T.M.Ramesh, Director, Indian Ocean Garnet Sands, Tuticorin for having come forward to provide financial support to this seminar as well as depute their staff members within the minimum time period. I am grateful to Sri.Tajuddin, ETA Shipping Services Pvt. Ltd. Tuticorin, for sponsoring financial support for this seminar that too, the moment he happened to see our request.

I also acknowledge with thanks the liberal financial support provided by Mr.G..Balu, Sri Mathura Studio, Xerox and Computers, Thanjavur, Mr. Rajan and Mr.Pragatheeswaran, Shrie System, Thanjavur, Mr.L.Ramakrishna, The South Indian Mines and Mineral Industries Ltd., Sankar Nagar, Tirunelveli, Ms.S.Chitra, Temple Travels & Tours, Thanjavur and Indian Overseas Bank, Nilagiri Vattam, Thanjavur.

I am highly indebted to Dr.N.Angusamy, Dr.P.M.Mohan, Mr.M.Suresh Gandhi and all my staff members and scholars for providing me untiring support to bring this seminar "A Dream in Reality". It goes without saying that the seminar is possible only with the interest and hard work of the participants from different organisations and permission provided by the respective administrators and executives.

Above all there are many more contributors in many respects in the form of physical and administrative support not only in this university but also from other organisations. I am thankful to all of them.

10/12/99

(G.VICTOR RAJAMANICKAM)
Convenor

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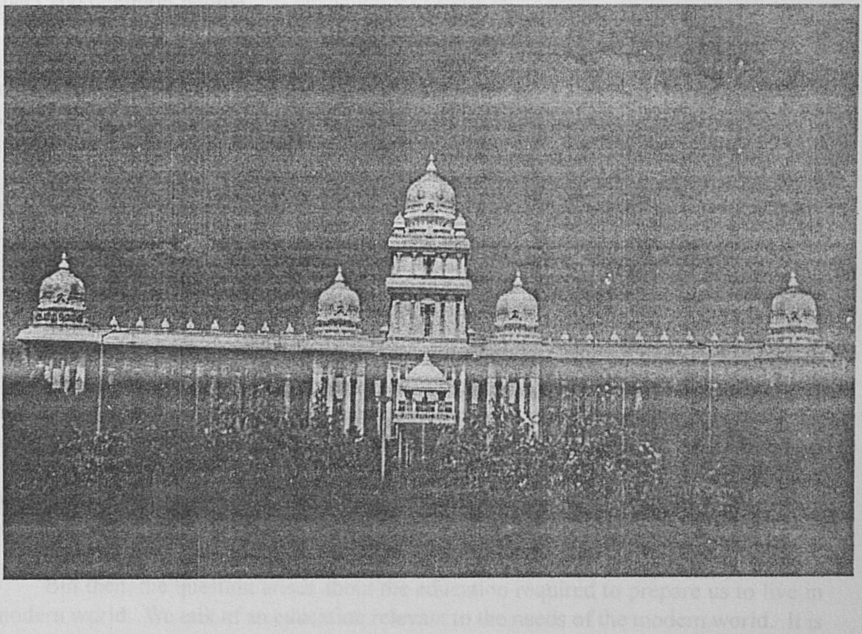
PROFILE OF THE UNIVERSITY



Tamil University

Tamil language, culture and heritage are like stellar wonderments in their enigma and origin yet to be unravelled fully from the shrouns of hoary antiquity. In pursuit of this enchanting wonderment, a dedicated and scholastic tool of exceptional calibre was needed resulting in the incorporation of Tamil University in Thanjavur. The Political Scientists and Modern Scientists professedly functioning in different areas of human thought would indeed be taken aback at the profoundity and rationality of ancient Tamil thought in their eternally luminous spectrum of human expressions, whether their life-styles or literary expressions, thus bringing them together on common idiom, not-withstanding their differing faculties and pursuits. Perhaps if Cardinal Newman were to be acquainted with some of the priceless literature of ancient Tamils with extraordinary insight into men and things, he would have found fulfillment of his ideas of a university in the very lifestyles of ancient Tamils, both scholars and common-people.

A University, in Cardinal Newman's inimitable phrasing, is a corporation of society which, while devoting itself to a search after knowledge for the sake of its intrinsic value provides for them, an ample scope for acquiring and integrated view of life, a sense of perspective and a synoptic vision. its function is to train men and women to study with insight, the records of human experience as they are expressed in the world's literature, to know the nature and consequences of ethical values, to sense the significance of the various forces operating in society and to comprehend the complexities and intricacies of life in all its immensity - physical, social and spiritual.

It is well and truly said that a nation's greatness is made by her artists and thinkers and scholars and philosophers. It is their life spirit that has shaped and unified India's collective and it is the same that perpetuates the real bond of oneness among the Indians. If our country is to confront and overcome the complexity of modern days, she must look for guidance only from her men of letters, men of science, her poets and her artists, for these are ever the intellectual stalwarts of civilization and they primarily emerge from the universities, the apex of the academic bodies. The universities are the sanctuaries of the inner life of a nation.

But then, the question arises about the education required to prepare us to live in the modern world. We talk of an education relevant to the needs of the modern world. It is often forgotten that modernity is not a question of date, but of outlook. Thiruvalluvar and Ilango, Kambar and Sekkizhar, the Alwars and the Nayanmars may not be our contemporaries in time; but they are our contemporaries in spirit. They never cease to have meaning for us for human nature changes little and human ideals change little. Techniques of study may alter and new techniques need to be learnt, but the more important and deeper things do not alter.

"One of the aims of education is to break the strong hold of the present on the mind", says the Harvard Report on General Education in a Free Society. How are we to give the mind this training to teach it to judge rightly its own age and itself? Only by showing it the greatest things which men have achieved or dreamed. So, and only so, it will have a standard, an example, an inspiration.

The ancient literature of the Tamils, like the literature of ancient Greece, impresses one not so much by the bulk, range and variety of the works that have been preserved for us, as by the comparative novelty and compelling nature of its contents, and by the light that it throws on the hoary and independent culture of the southern part of Peninsular India. And what a marvellous vision of excellence in sociology and statecraft, in political economy and public administration, in science and philosophy, in private and public conduct, and in art and architecture, music and literature, religion and faith this wonderful race of Tamils exhibit to us! And how very current, how very contemporary, how very modern, and how very novel breathes this vision in spirit! "We should not", says Aristotle, "listen to those who tell us that human beings should think like men and mortals think like mortals, but we should achieve such immortality, as we may, and strain every nerve to live the highest things in us". And where else, but in Tamil art and architecture, music and literature, do we have the daring achievement of mortals thinking like immortals, filled with immortal longings striving for perfection?

To see the vision of excellence, so far as our limitation allow; to get atleast a glimpse of the unchanging values of the eternal world as they are revealed in whatever is beautiful and good in the material world of earth; to attempt to make one's infinitesimal contribution towards a society which will embody them more fully than does our own - these are the aims and ideals on which the Tamil University has been founded.

Moreover, during the last two centuries some European scholar or other of nearly every generation has paid Tamil the tribute of a sigh, and insisted that Western scholarship ought not to neglect it, but even so, all the interest that has been created has only resulted in some stray compliment paid in a legendary language. "In the south of India there is an ancient language with an ancient literature". Of the interesting nature of that language and the still more interesting character of that literature, no scholar has made known to the world. Tamil had not its Max Mullers, Macdonells and Keiths, and even they have unwittingly prolonged the Western neglect of Tamil because by identifying Indian Literature with Sanskrit Literature, they have created the belief that Sanskrit literature is both exclusively and exhaustively representative of the Ancient Indian culture. Max Muller has written about what India can teach the West. By India he meant the Indo-Gangetic Plain. South India could have taught him even more interesting lessons. That such a culture and that such a literature as those of Tamils in India remain hidden and unknown in an age which is for ever excavating the nooks and crevices of the past and searching for the characteristic contributions of every race, is worthy of enquiry.

It is with this holistic purpose in view that even as far back as 1925 the idea of starting a Tamil University was mooted though it took nearly sixty years for the idea to materialise in its present shape at Thanjavur. And it is also fitting and proper that it should have taken shape in the heartland of Tamil Nadu and in the ancient capital city of the later Cholas, thanks to the foresight and commitment to higher values, of the then Chief Minister of Tamil Nadu Dr.M.G.Ramachandran. The situation of the Tamil University could not have been more happily chosen, for Thanjavur is not only the granary of Tamil Nadu but also its cultural nucleus. The town lies in the heart-land of Tamil Nadu, redolent with historical associations as the seat of the Imperial Cholas. It is also the cultural capital of Tamil Nadu especially for music, dance and architecture which were encouraged by successive monarch-minsterals as patrons of traditional artists and craftsmen. So much for the suitability of Thanjavur to have been chosen as the venue for the academic structure of Tamil University.

"Let creative thoughts of Science and technology come to us from all sides through Tamil", sang the national poet Bharathiar. The University remembers these golden words by translating modern science and systems evolved in the advanced countries in to Tamil for common usage and for pursuit of truth in all facets of its endeavours of research. Nay, it further aspires to make its own contributions of scientific temper in the medium of Tamil for the sum total of human thoughts, through the flowering of its efforts of all kinds in its journey towards the realisation of the objectives of the founding architects of the university.

Its aims are as follows:

1. It is a unitary type of University with no affiliated colleges and no under-graduate or post-graduate courses of study. It is meant solely for higher research and advanced study in Tamil language and literature and of a few other allied disciplines. This does not preclude the University from conducting academic research by offering full-time and part-time M.Phil., and Ph.D., programmes since 1992, in a few disciplines such as Literature, Language, Translation, Sculpture, History, Inscriptions etc.,

2. The university serves as a cultural cause way between Tamil Nadu and people of Tamil origin living abroad. It endeavours to conduct research in literature, arts, science, medicine, engineering and industries, linked to Tamil language and literature, past and present. For it must be pointed out here that through the ages, India and particularly Tamil Nadu have had an elaborate educational organisation by which the highest results were made available to the lowest members of society. History has recorded the evolution of forms of polity in accordance with the spirit of the locality and native instincts of local groups of communities. Tamil Nadu has had, down the ages again, masters who has created immortal forms of arts, not only in literature but also in poetics, grammar, prosody, music, dramaturgy, aesthetics, sculpture, painting, architecture and iconography. Again, there has been a highly developed system of industrial arts and matallurgy. Last, and perhaps the most important, in the past there had been thinkers who had clutched at infinity in their attempts to build up systems of metaphysics, spiritual culture and religious realisation. Their whole object as men of culture

was "to see life steadily and see it whole". The Tamil University seeks therefore, to discover, preserve and display, promote and propagate rare manuscripts not yet printed and inscriptions which bring to light the cultural greatness of our forefathers. For the chief sources of spiritual nourishment for any people must be from its own past, perpetually rediscovered and renewed. A society without a knowledge of the past and understanding of its heritage would be lacking in depth and dignity.

3. The Tamil University seeks to function as a cultural link providing facilities for the exchange of thought from Tamil to other languages and vice versa, through translations. It is also a seed bed for enriching and using Tamil for the growing needs of science in schools and colleges. For the world we live in, is one in which science and technology have advanced by leaps and bounds, with profound changes in our environment, in our world and in the universe. It is but natural that more and more emphasis will be placed on science and technology in universities and it is right and proper that students of humanities and social sciences must become more familiar with science and the scientific spirit.

On the whole the Tamil University serves as a good touchstone to assess the impact and influence of Tamil culture upon every cultural entity in India with scholars young and old, working constantly for the enrichment of Tamil culture and ethos by a judicious blending of ancient and modern.

The Vice-Chancellors

It was the good fortune of the Tamil University that a reputed Tamil scholar, a linguist of international reputation and an astute administrator like Dr.V.I.Subramoniam, was entrusted with the task of planning and nurturing the university in its initial stages. His services to the University as its founder Vice-Chancellor are phenomenal. His immediate successor Dr.S.Agesthialingom, the reputed scholar maintained the high standards set by his predecessor and developed the University. Dr.C.Balasubramanian, the eminent Tamil Savant, who followed him, continued the good work of his predecessors. After him Dr.Avvai Natarajan, is a distinguished scholar, endowed with known for his inimitable wit and humour and whose silver-tongued eloquence has made him a household name in Tamil Nadu. He brings to bear on his high office, his rich experience in administration which he has acquired by years of proximity to the nerve-centre of the administration in Fort St. George. He continued to keep up the growth of the University in line with his predecessor. Following him Dr.K.Karunakaran, an endowed linguistic professor took up the responsibility of bringing this University in the lime light of the international arena. His depth in academic experience could rejuvenate the spirit of research in this University. The present Vice-Chancellor Dr.C.K.Mahadevan, an ardent academician imbibed with military discipline has taken over the administrative responsibility of this University. His administrative efficiency and eloquence in understanding the humanitarian needs have brought an ocean change in the life of academicians and students of this campus. The Univesity could see the bright future not only in the financial aspect but also in the upcoming of the research activities to the level of international reputation.

This University could establish a Centre for Excellence for Placer Minerals in the Department of Industries and Earth Sciences. To effect that, a Memorandum of Understanding has been made by the Secretary, Tamil Development and Culture of Government of Tamil Nadu with the Secretary, Department of Ocean Development of Government of India, New Delhi. It is going to be a permanent centre with multi crore investment for man power development in the field of Marine Mineral Exploration, enabling the contact of the Multinational community. It is the only one of its kind for the mineral exploration in the country.

Tha Campus

A thousand acres were acquired for the University, thanks to the munificence of the Government, to house the various buildings and structures required for the ambitious plans of the founding fathers. An imposing administrative block with the gopuram motif of Chola architecture built at a cost of Rs.Three crores, a magnificent edifice, the biggest University Library in India, to house the books, a Language Block in the shape of the letter ' ' peculiar only to the Tamil language, Karikalan Auditorium with the capacity of 500 members, an open air theatre, hostels separately for men and women, besides residential quarters for the professors, Associate Professor, Lecturers and the ministerial staff and a medium-sized hospital have all come up in the Campus. The saplings planted years ago, have begun to grow up, providing the scholars with many a green shade to cogitate under, as in the Groves d' Academe of ancient Athens.

Faculties and Departments :

1. Arts	- Sculpture, Music, and Drama
2. Manuscriptology	- Palmleaf Manuscripts, Rare Paper Manuscripts, Epigraphy, Underwater Archaeology
3. Developing Tamil	- Tamil Studies in Foreign Countries Translation, Lexicography, Social Sciences, Scientific Tamil Tamil Development
4. Language Faculty	- Literature, Linguistics, School of Philosophy, Centre for Tribal Studies, Folklore, School of Indian Languages
5. Science	- Siddha Medicine, Ancient Sciences, Industries and Earth Sciences, Computer Centre, Architecture

The Tamil University, Thanjavur, a high level unitary research institution has been striving since its inception in 1981 for academic excellence. The main aims are to undertake advance research in the domains of Tamil Language, Literature, Grammar, Philosophy, Culture Tamil and Tamil Society. Also this university aims at developing Tamil Language as an effective vehicle for modern science and technology and for achieving this aim, it has undertaken various projects through its 5 Faculties and 23 departments. Some of the projects which were undertaken since its inception are still continued while some new projects have been initiated on the basis of the felt need.

As regards the projects that are continued from the beginning. The following are worth mentioning. 16 volumes of the Encyclopaedia have been completed and the remaining 4 volumes are being edited. Some of these volumes will be published during 1999-2000. The publication of Text books in Tamil in the field of Engineering and Medicine was welcomed by the Scientific Technical personnel and so far nearly 20 text books have been printed and published. About 10 books are yet to be printed. Glossaries of Science Terminology have been completed in several volumes.

Refresher Courses

The Tamil University has been conducting refresher courses to the University and College Teachers during the past and similar programmes will be conducted in the new and emerging areas where the teachers need the exposure. The Tamil University has also been conducting training programmes for the IAS, IPS and IFS trainees who belong to other States. The Government of Tamil Nadu had been continuously deputing these officers for language training. This programme is also being continued for the future.

International Relations

The Tamil University had been continuing international and national seminars in collaboration with the international and nation organisations. Since these seminars provide for interaction of scholars of national and international repute. Such seminars are also continued during the year 1999-2000.

Lexicon

The Government of Tamil Nadu have entrusted the task of publishing Dictionaries of Technical terms in Tamil to the Tamil University. Some of the volumes have already been published. The remaining volumes will be broughtout during the year 1999-2000.

Assistance for Research Scholars

The Tamil University has been offering M.Phil and Ph.D. Programmes in specialised areas which are not offered in other universities. Nearly 150 M.Phil and Ph.D. students are

recruited every year and these research programmes will continue to form part and parcel of the activities of the Tamil University during the year 1999-2000. Rs.750/- per month scholarships has been dispersed to 5 students of Ph.D. and M.Phil., for each Department from out of the two endowments created by the Tamil Nadu Government in the name of Bharathiyar and A.T.Panneer Selvam, from April 1998.

Extension of Research Activities

The Tamil University was having extension centres at Kancheepuram, Mandapam, Chennai and Udagamandalam during its formative years. Due to administrative problems these centres had been brought to Thanjavur for effective supervision. However, now it is thought that the extension centres can grow only when they are situated in the places where they were originally started. As a first step, it has been proposed to shift the School of Philosophy to Kancheepuram which is a place of religious and culture activities. Similarly, the Centre for Underwater Archaeology of Tamil University is proposed to be shifted to the Mandapam Camp which would enable the centre to grow as centre of excellence.

The University has proposed the establishment of a centre of Language Planning to fulfill the need of the society in the use of language as well as to aid the policies of the nation. This centre would be undertaking various types of Lexicographical Studies, Translation Studies, Encyclopaedia Studies and involve in the preparation of glossories of technical terms and publication of next books.

Translation

Translation is an important area for the development of the language. The Tamil University has felt the need for translation and brought out many publications in the past in the field of English and Tamil Literature. A workshop on Translation was conducted in which many scholars had participated and the University has planned for the Translation of all the Diactic works in Tamil into English. These works will be published during the year 1999-2000.

The Tamil University is a pioneer university among the language universities in South India, to enrich and develop the respective languages.

A uniform approach for the language development was considered necessary and a Forum of Language universities was created among these universities and the interaction between these universities would help exchange of scholars and literary materials among themselves. It is proposed to undertake more inter-university programmes in the language research and development.

Researxh Centres

New Research Projects such as Tolkappiyar's Paviyal Study, A Sociolinguistic profile of Tamil Nadu, reference grammar of Tamil, Beach Placer Minerals etc., have been undertaken. The department of Ocean Development has chosen the Department of Earth Sciences for setting up a Research Cell for Beach Placer Minerals during 9th Plan.

The Tamil University is well aware about the dawn of the 21st century and it is preparing itself to meet the requirements of the technical advancement. The library of the Tamil University has already equipped with the computer information service and INFLIBNET facility. During the year 1999-2000 it is proposed to provide INTERNET facility so as to provide access to the entire world universities. Similarly the department are also being provided with computer facilities for modernisation of their research activities.

The UGC has approved three academic centres and sanctioned Rs.150/- Lakhs viz. Centre for performing Arts, Centre for Language and Centre for Historical Studies during the 9th plan Period. A proposal has been sent for UGC for the Establishment of Special Cell for Scheduled Castes and Scheduled Tribes with a view to watch effective implementation of reservation policy in recruitment and selection.

Evaluation of Academic/Non-Academic Staff Activites

In the year 1995 the Tamil Nadu Govt. constituted a committee under the chairmanship of Dr.V.C.Kulanthaisamy, former Vice-Chancellor of Indira Gandhi National Open University to reform the entire activities of the Tamil University. Based on the report of the committee the Government of Tamil Nadu issued a G.O. in the year 1998 for necessary action.

Similarly an Academic Evaluation Committee was constituted by the Government of Tamil Nadu to access the academic and research activities under the chairmanship of Dr.S.V.Subramaniam in the year 1998.

With the view to generate funds to the University and help the students of Thanjavur, Trichy and Nagapattinam Districts who aspire for IAS, IPS and IFS entrance examinations, the Tamil University is going to organise and conduct Tamil coaching classes from 1999 onwards.

Thus, the policy of the Tamil University is based on the consolidation of the existing facilities, continuation of the on going programmes and need based innovative programmes for the future requirements.

University Establishment

1. Area covered by the University Campus in acres : 925 Acres
2. Built up areas of the University building in Sq.metres : 26.335 Sq.Metre
3. Staff Quarters

Professor	:	4
Reader	:	4
Lecturer / Officer	:	17
University Staff	:	17

4. Hostels	: 2
a) Number of Rooms for boys Hostel	: 12
b) Number of Rooms for Girls Hostel	: 10
5. Auditoriums	: 8
6. Roads in the Campus	: 6,185 Metres
7. Water Pipelines	: 14,108 metres
8. Overhead watertanks of 1 lakh litres capacity	: 3 Nos.
9. Deep Borewells	: 8 Nos.
10. Electric Motors	: 7 Nos.
11. Street Lights	: 351 Nos.
12. Electric Points	: 4,036 Nos.
13. High Power Transformers	: 150 KVA - 1 No.
14. Generators	: 250 KVA - 1 No. 163 KVA - 1 No. 21 KVA - 1 No. 11 KVA - 1 No. 2 KVA - 2 Nos.
15. Power Connections	: 22 Nos.
16. Air Conditioners	: Duct type 57.5 TR - 2 Nos. Window type - 30 Nos.
17. Students	
M.Phil.	: 62
Ph.D.	: 120
18. Teaching Staff	
Lecturer	: -
Senior Lecturer	: 1
Reader	: 32
Professor	: 28
Total	**: 61**

PROFILE OF THE DEPARTMENT

Introduction

The Department of Industries, the brain-child of Dr.V.I.Subramoniam, has entered into the realm of research field at the right earnest in 1982. Prof.A.Subramanian has initiated research works on the "Ship Building Technology", and "Iron Industries of Tamil Nadu" during Cholas' period. With the view to gain momentum in the budding field, a symposium on "Under Water Archaeology and Ancient Metallurgy" has been conducted during his period. Dr.S.Palani, who took over as the Head of this Department in October, 1984, continued the studies with wider perspectives. From December 1985, under the dynamic leadership of **Dr.G.Victor Rajamanickam,** the department has scaled new heights in the research field. In order to expand the scope of research into other sciences as well as to give impetus to scientific research using advanced techniques, the department has been redesignated as **Industries and Earth Sciences.** The department has made its presence felt nationally as well as internationally through its qualitative scientific turn-outs.

Objectives

1. To establish Scientifically and an industrially well advanced state, especially in the field of earth sciences like geology, geography, oceanography, environmental management and augment the scientific manpower build-up in earth sciences for natural resource management, conservation and preservation.

2. For establishing an advanced research centre in the fields of marine studies especially in pollution monitoring, coastal zone management, coastal mining and mineral resource management, remote sensing, applied geomorphology, etc., which help to look after the welfare of Tamil Nadu.

3. For studying the similarity and compatibility of the ancient science and technology developments of Tamil Nadu in relation to the other parts of the world and harness the different techniques for modern industrial usage.

4. For collecting sufficient data on the basis of experimental science for reconstructing the traditional scientific and industrial techniques so as to popularise the same adopted by our ancestors.

The Department is geared-up to establish the infrastructural necessities including well-established scientific laboratory to carry out advanced studies in geology, geomorphology, metallurgy, soil science, oceanography and meteorology. Presently, the laboratory is oriented to undertake research in the above subjects. It is worth to mention that the laboratory is totally equipped mainly through the support of the funding agencies.

Considering the meritorious research done during the last decade in this university, this department has been chosen as the **Centre for Excellence on Placer**

Minerals. At present it is designated as **Ocean Science and Technology Cell (OSTC). Prof.G.Victor Rajamanickam, has been appointed as distinguished Professor and Research Coordinator** for this centre. This is considered to be the nodal centre in research on placer minerals in this country with all types of research on placer minerals. Keeping in mind the national interest, the centre will be extended with all infrastructural facilities by the Ministry of Ocean Development to the tune of few crores in the plan period.

This department is aimed to encourage multi-disciplinary and multi-organisational projects. The following list of staff members may throw light on the proficiency of this department in the wide spectrum of interdisciplinary fields.

	Name and Designation	Basic Qualification	Date of Joining
1.	**Dr.G.Victor Rajamanickam** Senior Professor & Head	M.Sc. (Geology) Ph.D. (Marine Exploration)	11.12.85
2.	Reader (Mineral Exploration)	(Vacant - Filling up in Process)	
3.	Reader (Resource Management)	(Vacant - Filling up in Process)	
4.	Lecturer (Marine Geology)	(Vacant - Filling up in Process)	
5.	Lecturer (Micro Palaeontology)	(Vacant - Filling up in Process)	
6.	**Dr.P.M.Mohan** Project Scientist	M.Sc. (Marine Geology) Ph.D (Marine Geology)	01.09.93
7.	**Dr.N.Angusamy** Research Assistant	M.Sc. (Geology) Ph.D. (Mineral Exploration)	01.09.89
8.	**Ms.V.Kannagi Devi** Technical Assistant	M.Sc. (Chemistry)	29.09.87
9.	**Mr.D.Balasubramanian** Assistant	M.A. (English)	08.07.99
10.	**G.Balakirshnan** Office Assistant		17.07.97

INSA Project

1.	**Ms.S.Helen Kasimir** Project Assistant	M.A. (History) M.Phil. (History)	10.08.98

Name and Designation		Basic Qualification	Date of Joining
2.	**Mr.A.Ganesh Pandi** Technical Assistant Cum Data Entry Operator	M.A. (History)	13.08.97

DST (R&D) Project

1.	**Mr.R.Karikalan** Field Investigator	M.Sc. (Geology) M.Phil. (Mineral Exploration)	05.08.98
2.	**Mr.V.Ganesan** Field Investigator	M.Sc. (Mathematics) B.Ed. (Mathematics) P.G.D.M.M. (Marketting Management)	05.08.98
3.	**Mr.J.Senthil Kumar** Programmer	M.Sc. (Computer Science)	12.05.99
4.	**Ms.A.Umma Sabitha** Field Investigator	M.Sc. (Geography) M.Phil (Earth Sciences)	12.05.99
5.	**Ms.R.Sivagama Sundari** Data Entry Operator	B.Com.	06.08.98
6.	**Mr.P.Vadivel** Draughtsman	ITI (Civil)	20.08.98

UGC (Dictionary) Project

1.	**Mr.G.Swaminathan** Project Assistant	M.A. (Tamil) M.A. (English)	10.11.98

Work Completed

1. "Maritime history of South India as gleaned from the South Indian literatures", sponsored by NISTADS to the tune of Rs.3.0 lakhs with the duration from April 1984 to March 1987.

Materials concerned with the Navigation and Ship building, prevailed mainly during sangam age have been compiled from Tamil literature. Subsequently, a similar compilation has been carried out from ancient literature of Kannada, Malayalam and Telugu. Elaborate

reports have been submitted separately for each language Tamil, Malayalam and Kannadam, each running to about 250 pages. Presently, these compilations have been edited as a book entitled 'Maritime History of India'.

Mrs.M.B.Seward, Department of Oceanography, University of Southampton has brought this volume to the notice of the International community through the following note to 'Mariner's Mirror'.

'I do not know whether you sent copies to anyone else in the United Kingdom, but I have sent a note, a copy of which I enclose, to the Editor of the Mariner's Mirror' as this is the principal journal on maritime history in the United Kingdom. If the appearance of these volumes has not already been noted there, I hope we will insert it as it is best place to bring them to the attention of people interested in the history of ships and shipping'.

2. "Maritime history of South India" - Phase - I: Oral Tradition sponsored by CSIR to the tune of Rs.8.53 lakhs with the duration from July 1987 to February 1991.

Appreciating the work done by the department under the sponsorship of NISTADS, CSIR came forward to provide financial support to compile the existing oral tradition, prevailing among the fisherfolk, sailors, ship builders and other mariners. Under that, a project entitled "Maritime History of South India" was completed. Four scholars, one for each state, have collected the required data from the mariners of Tamil Nadu, Andhra Pradesh, Kerala and Karnataka.

Under that study, the data on the commonly prevailing traditional boats characteristic to the respective region and locality have been compiled. There are about 11 traditional boats in Tamil Nadu, while 8 in Andhra Pradesh, 6 types in Karnataka and to in Kerala still in use. It was interesting to note that even after so much of impact of colonization in our country, the ship builders of that region continue to maintain the traditional ship building techniques. Even today the boat builders in the rural areas, try to shun the use of nails in the boats. The details collected regarding the seasoning of woods, the bending of planks, the methods applied to avoid wood borers, the suturing of planks, the strengthening of sails and nets, etc., have reflected the scientific supremacy which we maintained many centuries ago.

Above all, it is, indeed, curious to know that our mariners are still doing maritime activities with our traditional boats without the modern navigational and communicational aids. In certain areas the knowledge of stars and sun's movement was found extremely good. It is interesting to know that fishermen selectively use some stars and avoid Planets and some bright stars for their navigation. In all these areas, the fishermen are found to have been acquainted with typical stars like Orion, Caseopia, Crux, Fomel Haut, Capella, Pole Star, Alpha Phoneix, Alpha Centauri, etc. Along the east coast, the fishermen were seen to measure the altitude of the horizon by simple visual estimation and in some places they have used the oars or the poles to measure the height. As the knowledge of stars is vanishing

fastly with the appearance of light houses and other prominent coastal objects, it is indeed essential to record the existing knowledge immediately. This project has met such expectations.

In addition to the gathering of the informations on traditional shipping industries, the survey has also brought out some interesting facts of the existence of many stone anchors. Recently, our survey has shown that the community fishing using the padavu is on the verge of extinction along the Karnataka coast. This fact is really alarming to note, as it indicates loss of our rich ancestral heritage.

It is worth to mention here that the selected typical traditional boats have been brought as prototype models and displayed in the maritime museum in the department. It is the first attempt in this country to preserve the tradition.

NLC Project

3. **"Heavy mineral Distribution for borehole samples from the overburden and underburden samples of the Lignite Seams"**, sponsored by NLC to the tune of about 6 lakhs.

About 388 bore hole samples collected from the depositional basins of Mannargudi, Veeranam, South of Vellar, Jayamkondam and Bahur in Tamil Nadu and Bholasar, Barsinghsar, Giral, Bithnok blocks in Rajasthan area were analysed for deciphering heavy mineral suites to understand the depositional conditions of the different basins and their provenance. Among the six basins studied for heavy minerals four basins, except Neyveli and Bahur regions, show a clear cut presence of oscillation of water level in different depths of the basin. Each oscillation is represented by the deposition of denser heavy minerals. Each basin is enriched with the assemblage of denser heavy minerals with respect to the varying physico-chemical environment and the depositional conditions. The Mannargudi basin is characterised by the distribution of denser minerals like zircon. The major contribution of the sediments is presumed to have come from the Tertiary sediments. In Jayamkondam zircon and kyanite, flaky minerals are also appreciably distributed. The presence of more flaky minerals evidences the closed nature of the basin for undisturbed deposition of sediments. The Jayamkondam basin must have received supply from northwest and western directions from the lower Tertiary deposits. South of Vellar basin shows more amount of flaky minerals reflecting the partially closed nature of the basin. The Veeranam basin should have received sediments mainly from Cretaceous deposits exposed in the periphery of the basin.

The five different blocks of Rajasthan area show characteristic mineral assemblages with respect to varying lithology of the sediments. The Barsinghsar block shows distinct oscillations at three different depths. The Bholasar block shows the enriched distribution of kyanite and other lighter minerals at shallow depth. In this block two stages of oscillations can also be inferred by characteristic shift in the mineral assemblage. In Gurha block typical

mineral assemblage is represented by glaucophane, tourmaline and garnet minerals. The flaky minerals variation in this basin leads to infer the closed nature of the basin during the deposition of sediments. In Bithnok block three stages of oscillation are evidenced from heavy mineral variations. In Giral block a marked shift in mineral distribution is brought out at three different depths.

In Giral block the source of sediments should have come mainly from eastern direction.

The Q-mode factor analysis reveals that Neyveli region heavy mineral assemblage shows better grouping and differential segregation in different basins but in Rajasthan the influence of all the three factors characterise the basinal sediments. But for minor changes both the region show a similar assemblage factor dominated by garnet, zircon and kyanite.

DOD Project

4. "Beach placer exploration along the coast between Mandapam and Kanyakumari", sanctioned by Department of Ocean Development for Rs.8 lakhs.

About 568 samples were collected from the foreshore and backshore regions of the beach along the coastal stretch of Mandapam to Kanyakumari at an interval of 10 Km. The Samples were analysed mineralogically and geochemically. On the basis of tonnage formula the total reserves of the beach placers were estimated. On the basis of a comprehensive geomorphic map, the geomorphic controls on beach placers have been brought out.

From the distribution of heavy minerals along this coast it is inferred that the economically viable mineral deposits are concentrated only in Kanyakumari to Kuduthalai and in Kallar - Vaippar regions. The existence of downwarping basins due to neo-tectonic activities in Kanyakumari and Tuticorin regions has acted as sedimentation trap for the deposition of heavy minerals, being pushed in by northerly moving oceanic currents. The chemical analysis of major, minor and trace elements of ilmenite, magnetite, zircon and monazite have clearly projected its compatibility with other deposits both in the country and outside.

From the assemblage of heavy minerals the source rock are inferred to be of mixture of charnockite, khondalite, granite and other low and high grade metamorphic rocks and early sedimentary deposits. The distinct presence of monazite in Kanyakumari block is assigned to their derivation from the oceanic sediments.

CSIR Project

5. "Maritime history of South India" (Indigenous Traditions of Navigation and Ship Building in Indian Ocean Phase - II) sponsored by CSIR, to the tune of Rs.6 lakhs for a period of 3 years from March 1991 to February 1994.

The aim of the project report is to reveal the traditional navigation and boat building technology that still prevails among the fisherfolk, mariners, navigators, and boat builders all along the Southern Peninsula. The maritime activity in the Indian Ocean can be traced back to the primitive ages. Most of the Civilizations are found to have flourished along the shores because of the extensive use of sea-faring vessels for trade, transportation and communication. Hence, this study aims at a discussion of the distribution of the crafts along the Indian coast, a discussion of the regional specialisation of crafts in relation to its geography, ethnicity, etc., the availability and use of raw materials like timber, coir, metal, oil and so on, the types of boats, its peculiarities, its different parts, the maintenance and management of these vessels and finally an analysis of how far they are found to deviate from their traditional way of boat building and being influenced by the foreign elements.

Important and worth mentioning results of the volume are the collection of ship building traditions from among the tribes of Andaman and Nicobar Islands. In some cases the tribes like Onges, Shompens, are isolating themselves from the mainstream of the people. However, with the help of department of Anthropology, their boat building techniques have been gathered. The rich tradition of race boat culture of Kerala has been brought to record. More details and technology involved in such race boats have been collected from a family engaged in boat building for centuries. Their family scrolls and records were made available for scanning. The information gathered from among the migrants of Andhra Pradesh into Andaman could help to understand that a slow transformation process is taking place, from the main land culture to the tribal culture. One could able to see the living practice of the Andhra mariners with the knowledge of Nava practicing the fishing in the Island waters and using the boat built by Bengali crafts men who is attempting sufficient alteration in his technique to suit the Andhra fishermen. The co-operation extended by the traditional ship building family like Mr.Coreira giving interviews for days together is considered to be a note worthy collection.

DST Project

6. "A study on the performance of students in National Educational Tests in South India" sponsored by DST to the tune Rs.13 lakhs, for a period of 3 years from September 1993 to August 1996.

During the field survey the prepared questionnaires were distributed to each community of the categories noted earlier. Completed questionnaires of 448 from NET failed, 500 from teachers and 446 from public categories were collected. In addition to the

questionnaire responses, a total of 108 interviews were conducted representing all the categories.

To know the factors responsible for the best performance of students, field surveys were also carried out mostly by conducting personal interviews in few selected best performing centers such as Roorkee University, Roorkee; Delhi University and Jawaharlal Nehru University, New Delhi; Indian School of Mines, Dhanbad; Calcutta University and Jadavpur University, Calcutta. Nevertheless, in each state two Brain Storming Sessions (BSS) were organised.

With regard to the personal background of the students, a higher percentage of educational level of the family members influence appreciably the NET passed category. Appreciable percentage of NET passed candidates are noticed to have been studied under the state board syllabus. The number of families in lower and middle income groups are observed to be aware of system of such test.

Regarding medium of instruction, around 70 % of students and teachers preferred the continuance of English in the field of Science and Technology. The out-moded teaching methods, lack of updation of the syllabi and the existing examination patterns are the three dominant factors which are considered to be the causes for the poor performance and they require an immediate attention of the policy makers. Inspite of the readiness of the academicians to get transformed themselves to the modern trend of teaching and to adopt up-to-date syllabus, the lack of infrastructure is pointed out as the stumbling block to reform the entire higher education syllabi and examination pattern.

From the various BSS and personal interviews the existence of teachers association in the form of trade unions, the intervention of politics in the campus of the higher education, the birth of self financing colleges, autonomous colleges and the policy of self-reliance in the education and research institutions have brought further set back in spreading uncontrollable forms of multivarious syllabi and examination systems. The students and public (77.0 %) have directly pin-pointed the lack of accountability of teachers as a major cause and they also desire to introduce the assessment of teachers by students to improve the accountability among teachers.

Dividing the syllabi on the basis of each subject, assuming a permanent employment for those passed NET, compulsory establishment of counseling and training in the colleges, re-orientation of examination pattern of NET, implementation of proper regulatory measures for teachers organisations, students evaluation of teachers, controlling the self-financing colleges without compromising the infrastructural facilities and publish a review on the performance of students in each appearance are some of the suggestions placed by the various categories surveyed for this purpose.

7. **"Evolution of Quaternary Landforms Between Vedaranyam and Rameshwaram, East Coast of India"**, sponsored by DST, to the tune of Rs.8 lakhs for period of 3 years from October 1993 to October 1996. (A collaborative project with IRS, Anna University, Madras)

On land around two hundred beach sediments from the fifteen stations have been collected. In each location samples have been collected using a hand auger from low, mid and high tide, berm and dune zones.

From the existing aerial photographs and satellite images available in Tanjore and Anna University, a geomorphological map has been prepared adopting visual interpretation method. From the geomorphological map different distinct landforms have been located for further sampling and ground truth confirmation. For the first time in this country offshore sediments in 8 traverses have been collected with Van Veen Grab upto a depth of 12 m by engaging a fishing trawler with the help of coastguards.

The results of the grain size analysis indicate that the present day process (nearshore environment) of depositional activities has developed the coastal sedimentary environment in the paleopast and sea level oscillation might have been significant only once in this part in the paleopast. This part of the area must have been developed with in the 25,00 years B.P.

The variation in different kinds of heavy minerals present in the inland, beach and offshore environments support the process of nearshore environment and also reveals that a continuous sequence of deposition might have occurred during the paleopast.

From the benthic foraminiferal studies off Palk bay, the following conclusions have been made out.

Twenty eight species belonging to twenty two genera have been identified. Of which two are arenaceous agglutinated, six are calcareous porcellaneous and the rest species are calcareous perforate.

The following species are found to have widespread occurrence in more than six stations. They are ***Ammonia beccarri tepida, Elphidium crispum, Edentostomina cultrata, Pararotalia nipponica, Quinqueloculina seminulum, Rupertianella rupertiana, Spiroloculina communis and Triloculina trigonula.***

A comparative study of the foraminiferal assemblages of the present area with those of other coastal waters reveals that only two species namely, ***Elphidium crispum, Triloculina trigonula*** show an uniform distribution in all the places.

The Q-mode cluster analysis has shown that the genus ***Ammonia*** is concentrated in the areas of biotope A viz., Mandapam, Algankulam, Manalmelkudi and Kodiyakkarai. The remaining areas of biotope B such as Devipattinam, Thondi, Kottaippattinam,

Sethubhavachathiram are found to be dominated by the genus ***Pararotalia***. The salinity nature of the coast, vegetational cover and substrate are the prime factors in offering an appreciable living conditions for species of the Strait.

8. **"Identification of coastal placer deposits along the coast between Maduranthagam and Madras"**, sponsored by DST (SYS) to the tune of Rs.2.9 lakhs for period of 2 years from May 1995 to April 1997.

The study of heavy mineral placer along the East coast of India, especially in Tamil Nadu, has not been given much importance by the various Government Agencies in their programmes. In view of this fact, the present study is warranted to locate the economically workable buried coastal placer mineral deposits and to evaluate the resources of such placer minerals along the coast of northern Tamilnadu, from northern border of Pondicherry in the south to the Ennore in the north.

The coastal stretch from low tide to berm and dunes, was surveyed for the collection of sand by auger for at least 1 m depth with a station interval of about 10 km. During the survey beach profiling, an account on vegetation, and faunal distribution were carried out.

On the basis of different studies like texture, mineralogy, and elemental chemistry, at a depth of 3-4 m in the strandline environment of the present day coastal area, the presence of buried placer deposits is identified. The probable reserves of these deposits in the study area are roughly estimated to the tune of 2.28 to 22.84 MT of ilmenite and 2.04 to 20.40 MT of magnetite. The nature of ilmenites and magnetites are in the limits of the economically workable concentrations.

To estimate the available resources of this deposits, under CSIR Pool Officer Scheme, a detailed exploratory work already been started on the borehole samples collected upto 5 m depth in this area.

University Projects

Iron Industries in Ancient Tamil Nadu

From the excavation conducted by epigraphic department at Kodumanal, we could gather varieties of finished steel products like sword, knife, beads, shield, chisel, billhook, nails rings, needles and horse-stirrups etc. In addition to this, smelting furnace with brick wall could also be located. A crucible was removed from such smelters intact. Fine ash materials collected from such furnaces have been analysed through the C^{14} method and it was found that the period of this habitat was equivalent to sangam age.

In the meantime this department has surveyed the entire Periyar District for the slag accumulations and other Megalithic evidences. Appreciable slag heaps have been located

in about 20 different sites. Out of the 16 diagnostic types, recognized so far, 13 distinct types of slag have been identified by studying the surficial properties of these slags by the variations in colour, density, porosity, etc.

In order to evaluate the importance and evolution of this industrial site, a survey has been conducted in Coimbatore and Periyar districts among the smiths of the rural areas. The oral tradition has been compiled on the methods of fabrication of different iron artifacts and use of raw materials. This has also been supplemented by collecting large amount of available published records and inscriptions from the Government Museum, Madras; Archaeological Survey of India, Madras; Department of State Archaeology, Mandaiveli and Fort Museum, Madras. Over and above, a compilation from Sangam literature (more or less of Megalithic period) on the availability of different kinds of artifacts, the technology behind the Iron production and the social status of the smiths have been made.

In order to carry out the scientific studies on the artifacts collected from the excavation, a geochemical and metallurgical laboratory is being installed. The existing facilities may aid the department to complete the study of optical properties of minerals and ores, and the major and minor elemental chemistry.

The artifacts made of iron different slag materials, bricks and clay pipes have been taken to West Germany. The Institute of Mineralogy, Aachen Technical University is at present carrying out the analysis to estimate the furnace temperature at which the melting was done. The German National Mining Museum is carrying out the analysis of slag materials to evaluate the composition of the mixture used in the furnace and subsequently the type of extraction of the metal. A collaborative project, with these organisation is already in process.

In the meantime the various geo-chemical analysis for the different kinds of slags, the bricks and the finished products collected in this site are in progress in this department.

To supplement the scientific findings, a glossary of different finished steel products and the different tools used in Ancient Tamil Literature has been compiled from the different literatures mainly of Tolkappiam and Sangam works. Further, to get a comparative picture of the terminology used in the ancient literature and the existing tradition, a survey was conducted among the smiths of Periyar, Coimbatore, Salem districts. Keeping these materials a book entitled "Iron Industries in Ancient Tamil Nadu" is being published.

Finding out Ancient shoreline along the coast of Tamil Nadu

The area subtended between Mandapam and Kanyakumari has been surveyed for this work. Detailed geomorphological mapping has been done. Different stages of the beach rock and marine terrace developments, different sets of swales and ridges, prograding spits and bars have been identified. From the samples collected in a vertical terrace in Rameshwaram, C^{14} analysis has been done. For the first time in the country, an attempt of

C^{14} determination for such number of samples has been done. The age determined so, ranges from 140 years to 32,000 yrs. B.P. The lithological and mineralogical studies are in progress. Under this project, a Ph.D., thesis is produced.

The project has thrown light on the characteristic emergence prevailing in this area. The progressive emergence in turn, suggests the geographical locations of ancient ports like Periyapattanam and Korkai on the coast and the probable causes for the closure of these ports. This study has enlightened the importance of siltation problem in this coast. 14 research papers out of this project have attracted the attention of Oceanographers and Geomorphologists, due to its emphasis on the environmental hazards induced by emergence and siltation.

However, the continuation of the above projects is kept in abeyance for want of funds and staff.

Work in Progress

1. Quantification of Financial and Manpower Resources Devoted to Research and Development in Science and Technology from Academic Sector - South Zone, Sponsored by Department of Science and Technology, New Delhi to a tune of Rs.31 lakhs.

The DST has attempted to quantify the financial and R & D manpower resources in the academic sector in the past on few occasions. They could get only a partial response. In order to fill the existing gap DST felt to go for a project to concentrate on collecting the information of R & D manpower and financial resources of the same in S & T Faculties.

In this study, it is aimed to collect data on manpower and financial resources. The man power resources should surface out the enumeration of personnel engaged in the faculty members. M.Phil. or Ph.D. students and consultancy personnels who are actively engaged in research as well as academic activities. This manpower quantification should also estimate the full time equivalence (FTE) of research personnel.

Objectives

- to conduct a pilot study in order to validate the process of data collection and the indices emerged through BSS.

- to collect basic data on expenditures and manpower from various in the universities, in the affiliations, PG Science Colleges, Medical Colleges, Engineering Colleges, Agricultural Colleges of south zone.

- to carry out field survey to quantify active R & D manpower on full time equivalence by field of science, level, type of institution, state, etc.

- to quantify the output indices of academic sector.

- to carry out statistical analysis of R & D scenario within the area considered.

- to attempt classification of manpower on the basis of performance as well as financial and infrastructural facilities.

- to quantify intramural and extramural R & D expenditure.

- development of a software on the estimation of R & D expenditure in S & T for further years to come.

In this project, literature work is being carried out by visiting different libraries and various universities. Questionnaires have been prepared for data collection from Engineering Colleges, Medical Colleges and from Agricultural Institutions.

2. A Technical Dictionary for Earth system Sciences (English - Tamil), Sponsored by University Grants Commission, New Delhi to a tune of Rs.2.16 Lakhs.

Earth System Sciences are being introduced right from the primary school in the form of Geography. But, the different parts of Earth System Sciences like Geology and Oceanography are not being introduced as a subject in the school level. As they are being taught in the degree and post graduate levels, the development of the particular field and the awareness in the school level are not sufficient to motivate the children to get attracted to this particular field of science.

This University is interested to introduce the professional courses in the regional medium. For that purpose especially for introducing the Engineering, the subject on Earth System Sciences have to be developed in the regional medium very essentially, because it forms part and parcel of the subject like civil engineering. Further, popularization of the oceanography, the advancement of remote sensing and space technology warrants the younger generation to know much about the basics of Earth System Sciences. Under such circumstances an availability of dictionary in the mother tongue, will be of great use for the students as well as for the staff to understand the subject just to teach in a simplified manner.

Objectives

1. Compilation of the geoscientific terms on the basis of usage in the field of Earth System Sciences.

2. Translation of the same with suitable words in regional language, keeping in mind the regional and professional dialect without changing the meaning.

3. Formulate the technical Dictionary in the reverse order confined to the terms (Tamil-English) for ready reference.

4. Prepare a software to the common use, as a dictionary of ready reckoner type.

A compilation of technical terms in Earth Sciences is being done from the various books and the encyclopedia.

3. The Traditional Naval Architecture and Impact of European Influence (16th to 19th Century), Sponsored by Indian National Science Academy, New Delhi to a tune of Rs.1.5 lakhs.

In this study materials relevaant to the project are being collected from different libraries in various places to know the influence of Europeans technology in ship building. Some of them are reviewed below.

Since India's direct, and momentous, contact with Europe followed the discovery of the sea-route via the Cape of Good Hope, it would be appropriate to investigate first the impact of European seaborne transport technology, i.e. shipbuilding, on India's.

One feature of the indigenous shipbuilding craft that repeatedly drew the attention of European observers was that while Indian shipwrights constructed their vessels by the 'rabetting' method, Europeans took recourse to caulking. Since the entire vessel in medieval times was constructed of wood, various methods in carpentry were employed to join in timber or planks; and rabetting was one of them. A study of the close-ups of vessels depicted in Mughal paintings not only supports the European remarks, but, in addition, they also show other methods of joining the planks together of which there is no mention in European records.

It is only from the seventeenth century that an active response to iron anchors is discernible, in all probability under European influence. Farhang-i Jahangiri, a lexicon prepared during Jahangir's reign, refers to langar as made of 'iron (fixed) in the ground in order to secure the vessel from moving away'. Another lexicon, Bahar-i 'Ajam, compiled in the eighteenth century, describes langar as a 'heavy (piece) of iron attached to the vessel to prevent it from moving away'. Mir'at-ul haqa'iq, a diary written during the 1720s, also speaks of langar-i ahni, that is anchors of iron. Thus, somewhere around 1550 and 1600 Indians began to use iron anchors. This development quite fits in with the scheme of things: in point of importance, iron nails should have got priority; anchors could wait a while till the production of iron was large enough to meet the demands of shipwrights.

By 1610, Pyrard saw elephants drawing 'ships and galleys ashore, or launch them afloat'. He also refers to the use of capstans by the Portuguese. Another instance of the use of the capstan in India in the seventeenth century comes from Goa in the 1630s, when Mundy

saw a ship being launched into water with 'cables, capstans and a multitude of people'. Next, Bowrey (1670s) enthusiastically refers to the launching of ship on the Coromandel coast with a sketch explaining how a ship was hauled for careening with tackles and capstans. The information about its use during the seventeenth century at places which were intensely exposed to European techniques - Goa to the Portuguese, and Coromandel to the Dutch and English - is perhaps a reasonable indicator of the real situation.

Coming to metal sheathing, lead was occasionally used in European ships from 1670 till it was replaced by copper in 1761. Pyrard says that the Portuguese used lead at the 'seams and joining of the timbers' only.

Ph.D Awarded (9)

1. Economics of Exploration and Exploitation of Manganese nodules in the Indian Ocean with reference to India-**M.Manickam**.

2. Placer mineral reserve evaluation along the central Tamil Nadu Coastal Region-**N.Chandrasekar**.

3. Geological and Geomorphological Investigations related to sea level variation and heavy mineral accumulation along the southern Tamil Nadu Beaches, India-**V.J.Loveson**.

4. Petrogenesis of magnetite iron ore deposits around Thuraiyur, Trichy Dt., Tamil Nadu-**R.Baskaran**.

5. Geomorphology of the Northern Tamilnadu coast using Remote sensing Techniques-**K.Anbarasu**.

6. Heavy mineral placers in the nearshore areas of South Konkan Maharashtra:their nature, distribution, origin and economic evaluation-**A.R.Gujar**.

7. A study of Beach Placer between Kanyakumari and Mandapam, Tamil Nadu-**N.Angusamy**.

8. Geomedical approach to Filariasis-**Usha Elangovan**.

9. Micropalaeontological (Benthic Foraminifera) Study on the Depositional Environment of Palk Strait, East Coast of India-**M.Suresh Gandhi.**

Ph.D. Thesis in Progress (13)

1. Geoscientific investigation in the significance of **'Poonir'** as the medicinal component in Siddha medicine-**Dr.R.Elisa.**

2. Distribution and Provenance of heavy minerals from the Quaternary landforms of Northern Tamil Nadu coast -**R.Karikalan.**

3. Geomorphology of southern coast of Kerala-**A.S.K.Nair.**

4. Landslides in Tamil Nadu-**C.Mariappan.**

5. A Study of Rocky Shore Fauna-**M.Helen Paul**.

6. Provenance of Vaippar Basin Sediments, Southeastern Tamil Nadu, India-**P.Udayaganesan**.

7. Genesis of Beach Rock formation between the coast of Rameshwaram and Indinthakarai, Tamil Nadu, India, and their significance of paleoclimate and sea level variation-**J.Dajkumar Sahayam.**

8. Ground Water Modelling of River Basin-**Lal Thompson.**

9. Sedimentological Studies of Palar River Basin-**T.Rajasekaran.**

10. Industrial Mine Safety-**Dwarakan.**

11. Studies on Hydrothermal Synthesis and Structural Characterisation of Coordination Complexes of Mn(II), Co(II), Cu(II) and Zn(II) Containing the Ligands-**J.Jeyasundari.**

12. Geo-Agricultural Practices for Rice Cultivation in Thanjavur District-**A.Sathya.**

13. Environmental Impact Due to Limestone Mining in Sankagiri Region-**L.Ramakrishna.**

M.Phil. Thesis Awarded (16)

1. A study on detrital minerals from the sediments of Gadilam river basin, Tamil Nadu-**N.Muthukrishnan.**

2. A Study on detrital minerals from the sediments of Vaippar basin, Tamil Nadu-**P.Udayaganesan.**

3. Coastal Geomorphological studies of the region subtended between Mandapam and Devipattinam, Southern Tamil Nadu-**M.Chockalingam.**

4. A Study on detrital minerals from the sediments of Palar basin, Tamil Nadu-**S.Rajasekar.**

5. A study on benthic foraminiferal distribution in the sediments off Palk Strait-**M.Suresh Gandhi**.

6. A study of sediments from the Quaternary landforms of Parangipettai region, South Arcot District, Tamil Nadu-**R.Karikalan.**

7. Distribution of detrital heavy minerals in the southern Kerala coast -**Lal Thompson.**

8. A study on the influence of petroleum resources in the urbanisation of Narimanam region-**C.Viji.**

9 Tourism Development in Thanjavur District-**S.Usha.**

10. A Study on the Location and Diseases of the Primary Health Centres in Trichy District-**K.Parimala.**

11. A Study on the Location and Diseases of the Primary Health Centres in Pudukottai District-**K.Gothainayagi.**

12. A Preliminary Study on Coastal Geomorphology from Adirampattinam to Nagapattinam, East Coast of India-**R.Santhi Devi**.

13. A Preliminary Study on Coastal Geomorphology from Nagapattinam to Coleroon, East Coast of India-**G.Revathi**.

14. A Preliminary Study on Coastal Geomorphology from Devipattinam to Adirampattinam, East Coast of India-**A.UmmaSabitha.**

15. A Qualitative Study on the Self Sufficence of Electrical Resources in Kumbakonam Taluk-**R.Rajathi.**

16. A Qualitative Study on the Self Sufficence of Electrical Resources in Tiruvidaimarudur Taluk-**S.Ramamani.**

M.Phil. Thesis in Progress (15)

1. A Study on the Feasibility Tourism Development Nagapattinam District-**G.Hemalatha.**

2. A Study on Ground Water Pollution and its Impact in and Around Pondicherry-**A.Zahir Hussain.**

3. A Study on Ground Water Pollution and its Impact in and Around Karaikkal-**J.Sirajudeen.**

4. Groundwater Prospecting by Resistivity Survey Methods in South of Pattukottai-**T.Elizabeth Gnanamani.**

5. Groundwater Prospecting by Resistivity Survey Methods in Pattukottai-**R.Mahesh.**

6. Watershed Management of Mayiladuthurai Taluk-**B.Sumathi.**
7. Watershed Management of Orathanadu Taluk-**B.Amutha.**

8. Watershed Management of Kumbakonam Taluk-**G.Kalaiselvi.**

9. Watershed Management of Chidambaram Taluk-**A.Thirumansolai.**

10. Marine Water Pollution of Punnakkayal Region-**M.Vidhyavathi.**

11. Tannery Pollution in Ranipettai Taluk-**J.Selvi.**

12. Identification of Landslip Prone Areas in Kodaikkanal Region-**S.Seon Raja.**

13. Coastal Geomorphology of Parangipettai Region-**U.Gnanaprakasam.**

14. A Study on the Location and Diseases of the Primary Health Centres in Trichy District-**T.Ravichandran.**

15. Effects of Pollution in the Ground Water in Cuddalore Region-**C.Palani.**

Radio Talk by Staff

1. By Prof.G.Victor Rajamanickam

1. On **"Buried Poompuhar in the Bay of Bengal"** in All India Radio, Trichirapalli, on 26-5-87.

2. On **"Indigenous Tradition of Navigation and Ship building in the Indian Ocean"** at ALL India Radio, Port Blair, Andaman, during January, 1991.

3. On **"Kadal Uyarvu"(Sea level rise)** at ALL India Radio, Tiruchi during October, 91.

4. On **"Future of Palk Bay"** in All India Radio Tiruchi on 14.11.92.

5. In a group discussion on **"Pollution Control"** at All India Radio, Tiruchirappalli Station on 4.2.93.

6. In a group discussion on **"Possibilities of Mining in Tamilnadu"** at All India Radio, Tiruchirappalli Station on 20.5.93.

7. On **"Earthquakes"** at All India Radio, Trichirapalli Station on 1.11.93.

8. Delivered a talk on "The Aim and Growth of Ocean Research" at All India Radio, Tiruchirappalli Station on 10.11.99 and All India Radio, Tinneveli Station on 28.10.99.

Organised Workshops and Seminars

1. National level Workshop on **"History of Traditional Navigation and Ship building"** with the assistance from NISTADS, CSIR and DST during Oct.1986.

2. With the Department of Scientific Tamil, Tamil University, Thanjavur, the **Science day celebration** during Feb.1987 for a week.

3. A National Seminar on" **Sea level variations and its impact on coastal environment "** during June,1989

4. A workshop on **"Performance of Students in NET examinations in South India"** during september 12-13,1992 funded by DST.

5. A workshop on **"Evolution of East Coast of India during Quaternary"** during April 18 - 20, 1993 under the project IGCP-274

6. Ninth Convention of Indian Geological Congress and National Seminar on **"Acquisition and Appreciation of Modern Techniques in Earth Sciences related Industries"** from 5.10.93 to 7.10.93.

7. A training course on **Documentation of Traditional Vessel Building and Allied Techniques** with Prof.McGrail of Oxford University, sponsored by CSIR, during Feb.94.

8. A workshop on **Scientific Writing** jointly with Prof.P.G.Cooray, Colombo, Sri Lanka during March 1-3, 1995.

9. 7th Conference of Indian Institute of Geomorphologists (IGI) and a national seminar on **"Geomorphology and Society"** on October 1-3, 1995.

10. A workshop on **Science Indicators** sponsored by DST New Delhi, on December 25th,1996.

11. An International Seminar on **Quaternary Sea level Variation, Shoreline Displacement and Coastal Environment** from January 20th-26th, 1997.

12. Brain Storming Session on **Approach for Quantification of Financial and Manpower Resources Devoted to Research and Development in Science and Technology from Academic Sector**, During 13-14th October, 1997 Sponsored by DST, New Delhi.

13. **UGC Project Advisory Committee on Evaluation of Earth Sciences Projects**, During May 8-9th, 1998, sponsored by University Grants Commission, New Delhi.

14. Opening of **Ocean Science and Technology Cell (OSTC) and the National colloquium on Beach placers** under the auspices of Dept.of Ocean Development, during December 5-6th, 1998

15. **Tenth Group Monitoring Meet for SERC Projects- Earth Sciences**, Department of Science and Technology, from December 31, 1998 to 2nd January 1999.

16. **Seminar on Thanjai Vedhanayaga Sastrigal's contribution to Tamil and Science** on September 18,1999, Sponsored by Dept.of Rare paper Manuscripts, Tamil University

17. **International Seminar on Placer Deposits** to be held from Dec.14th-20th, 1999 Sponsored by Dept.of Ocean Development, New Delhi.

18. **Training Programme on Recording of Boat Building Techniques** in colloboration with Prof.Sean Mcgrail, Oxford University, U.K to be held from 14-22, 2000.

19. **Brain Storming Session on Coastal Resource Management and Conservation**, sponsored by Dept.of Science and Technology to be held from Jan.21-22,2000.

Unpublished Technical Reports

1987	History of Traditional Navigation- as gleaned from Malayalam Literature. Project Report from Tamil University to NISTADS, Vol.1, pp.124.
1987	History of Traditional Navigation - as gleaned from Kannada Literature. Project report from Tamil University to NISTADS. Vol.II, pp.80.
1987	History of Traditional Navigation - as gleaned from Tamil Literature. Project report from Tamil University to NISTADS. Vol. III, pp.108.
1989	Maritime History of India (Indigenous Traditions of Ship-building and Navigation). Preliminary report submitted to CSIR from Tamil University, pp.420, Fig.140, Tab:40.
1991	Final report of the project, " Indigenous Traditions of Navigation and Ship building ". Submitted in five volumes to CSIR, New Delhi.

Vol.1 Karnataka, p.101, Figs.14, Tabs.11, Plts.24
Vol.2 Kerala, p.103, Tabs.13, Figs.29, Plts.25
Vol.3 Tamil Nadu, p.103, Tabs.20, Figs.22, Plts.16
Vol.4 Andhra Pradesh,p.100, Tabs.16, Figs.21, Plts.21
Vol.5 Andaman & Nicobar Islands, p.75, Tabs.7, Figs.15, Plts.10.

1993 Final Report of the project "Beach placer mineral exploration along the coast between Mandapam and Kanyakumari" to the Ministry of Ocean Development, Government of India - p 150, Fig.40, Tables 20.

1993 Final Report of the project "Heavy mineral distribution for borehole samples from overburden and underburden, the lignite Seams" to Neyveli Lignite Corporation, Government of India - p 200, Fig.20, Tables 10.

1995 Indigenous Traditions on Boat Building Technology of India. Vol.II Ship Building - p.370 Fig.30 Plates.56

1997 "A Study on the Performance DST, of the Students in National New Delhi pp.124 Educational Tests (NET) : Phase I - Southern Universities" 100 pages. Figs.120 with Annexure.

1998 "Identification of coastal placer deposits along the coast between Maduranthagam and Madras", 180 pages with plates and Figures.

1999 "Evolution of Quaternary DST, Landforms between Vedaranyam New Delhi Rameshwaram, East Coast of India" 86 pages with plates and Figures.

Contribution to the Scientific Books

1. Edited (G.Victor Rajamanickam and Y.Subbarayalu) a book entitled " History of Traditional Navigation and Ship Building", Tamil University publication No. 102, Thanjavur, 1988, pp.192.

2. Edited (G.Victor Rajamanickam) a book entitled "Sea level variation and its Impact on Coastal environment" - Tamil University Publication No.131, Thanjavur, (1990), pp.443.

3. Maritime History of South India as Gleaned from literature (G.Victor Rajamanickam and V.S.Arulraj) Eighth World Tamil Conference Revolving Fund Publication No.1, Tamil University Publication No.158, Thanjavur, November 1994, pp.403.

4. Edited (G.Victor Rajamanickam) Special proceedings of IGCP - 274 project entitled "Evolution of Indian Coast during Quaternary" - in press.

5. Ships in Sangam Age. (G. Victor Rajamanickam & V.S.Arul Raj) - Almighty Publishers, Thanjavur, pp.63.

6. Edited the Proceedings of the IX Convention of Indian Geological Congress and National Seminar on "Acquisition and appreciation of modern techniques in Earth Sciences related Industries" - pp.267

7. Translated in Tamil the book entitled "Mining the Ocean", a CSIR Silver Jubilee Publication, pp.100.

8. Edited the Proceedings of IGCP -274 Workshop on Evolution of East Coast of India, Special issue in Tamil Civilisation, Tamil University - in press.

9. Editing the proceedings of International Seminar on Quaternary Sea Level Variation, Shoreline Displacement and Coastal Environment - Academic Law & Serial, New Delhi - in press.

Department facilities extended to other departments / universities

1. Department of Geology, National College, Trichy - Bharathidasan University.

2. Department of Geology, Presidency College, Madras - Madras University.

3. Department of Geology, Madras University, Madras.

4. Department of Earth Sciences, Kerala University, Trivandrum.

5. Centre for Earth Science Studies, Trivandrum.

6. Department of Marine Sciences, Cochin University of Science and Technology, Cochin.

7. Central Electro-Chemical Research Institute, Karaikkudi.

8. Department of Marine Biology, Annamalai University, Parangipettai, Chidambaram.

9. Department of Economics, Raja Sarfoji College, Thanjavur.

10. Department of Geography, Kundavai Nachiyar College, Thanjavur.

11. Department of Computer Sciences, Khadir Mohideen College, Adirampattinam.

12. Department of Physics, Government Arts College, Tiruvarur.

13. Department of Economics, APSA College, Tiruppattur.

14. Department of Geology, VOC College, Tuticorin.

15. Department of Geology, Annamalai University, Chidambaram.

16. Department of Chemistry, Jain College, Madras.

17. Physical and Geological Oceanographic Division, National Institute of Oceanography, Dona Paula, Goa.

18. Department of Civil Engineering, Periyar College of Technology for Women, Vallam, Thanjavur.

19. Department of Geography, Government Arts College for Women, Kumbakonam.

20. Department of Geology and Geography, St.Andrews University, St.Andrews, U.K.

Research Articles Published

S.No.	Name	International	National
1.	Dr.G.Victor Rajamanickam	30	87
2.	Dr.P.M.Mohan	2	12
3.	Dr.N.Angusamy	2	6
4.	Dr.M.Suresh Gandhi	2	5
5.	Mr.P.Udayaganesan	2	2
6.	Mr.R.Karikalan	2	4

6. NO. OF TEACHERS DEPUTED TO FOREIGN UNIVERSITIES AND DURATION

1. Prof.G.Victor Rajamanickam -DAAD Invitation, 1987- 4 Months.
   Aachen University, Columbo University, Sri Lanka.
   St.Andrews University, U.K. - 4 Months (Under UGC-Royal Society, UK Exchange).

2. Dr.N.Angusamy - Hamburg University, Germany - 6 Months.

3. Dr.M.Suresh Gandhi -Rajshahi University, Bangladesh - 1 Month.

7. NO.OF OUTSIDE TEACHERS WHO WORKED IN OUR DEPARTMENT AND DURATION

1. Prof.G.Glasby - United Kingdom Oceanographic Division, U.K.-1 Month-1992.

2. Prof. Michael J.Tooley, St.Andrews University, U.K.- 15 days - 1990.

3. Prof.Walter Lenz, Hamburg University, Germany -two weeks - 1994.

4. Prof.P.G.Cooray, Colombo Univerity, Srilanka - 15 days - 1995.

5. Prof.J.Kattupotha, Jayaverdanapura University, Sri Lanka - 15 days in 1989 and 15 days in 1996.

6. Smt.Dayamanthi De Silva, Geological Survey of Sri Lanka-15 days- 995 and 1996.

7. Dr.Shahidul Islam, Dept.of Geography, Rajshahi University-Bangladesh-10days-1996.

8. Dr.S.T.Ahmed, Dept. of Geology, Rajshahi University-Bangladesh - 10 days - 1996.

9. Dr.Subhash Chandra Das, Dept. of Geology, Rajshahi University-Bangladesh - 10 days - 1996.

10. Dr.Monowar Hossain, Dept. of Geography, Rajshahi University-Bangladesh - 10 days - 1996.

11. Dr.Rupa Singhe, Institute of Fundamental Studies, Sri Lanka - 15 days in 1995 and one week in 1996.

12. Dr.Conchon Odette, Universite de Paris - Sud- France - 15 days - 1996.

13. Prof.Sean McGrail, Oxford University, U.K. - 1 month during 1995 and 1 month in 1996.

14. Prof.Eric Kentley, Southampton University, U.K. - 25 days - in 1995 and 1996.

15. Dr.Lucy Blue, Southampton University, U.K. - 25 days - 1996.

16. Mr.Paul Howard, St.Andrews University, U.K. - 3 Months - 1996.

17. Mr.Jeremy Money, St.Andrews University, U.K. - 3 Months - 1996.

18. Prof. Michael J.Tooley, St.Andrews University, U.K.- 15 days - January 1997 and 1998 January.

8. COLLABORATIVE PROJECTS WITH OTHER UNIVERSITIES / INSTITUTIONS

An action plan is prepared on Interdisciplinary aspects of Palk bay and its need for protection in association with National Institute of Oceanography, Goa and Ocean Engineering Centre, Madras.

Association with National Institute of Oceanography, Goa is being established in the field of Marine mineral exploration and Coastal Engineering aspects.

Association with the Department connected to Earth Sciences in Bharathidasan University, Annamalai University, Madurai Kamaraj University, etc.

Association with Central Mining Research Station, Dhanbad in connection with research on mining and mineral exploration and environmental planning.

Collaborative research work is planned with Jawaharlal Nehru Centre for advanced studies on the crustal deformations of Peninsular India.

An exchange programme is envisaged with university of Southampton on Traditional boat building techniques of Indian ocean countries.

Collaborative project with University of Kingston, U.K, Rajshahi Universuty, Bangladesh and Department of Geography, Jayawardena University, Sri Lanka under the sponsorship of INQUA is worked out to study the shoreline changes.

A joint venture with Institute of Oceanography, Southampton is being worked out to understand the coastal dynamics prevailing along the Palk Strait.

A collaborative programme is envisged with Department of Geology, Florida State University, Florida, USA, for the TL Dating of Placer Minerals.

9. LIST OF MAJOR RESEARCH PROJECTS PROPOSED TO BE UNDERTAKEN IN THE DEPARTMENT

Proposals Sanctioned

A grant of few crores of rupees is expected for establishing the state of art infrastructure for centre of excellence on placer minerals under the auspices of Department of Ocean Development.

Beach placer mineral exploration between Vedaranyam and Pondicherry. Rs.27.86 lakhs - Sanctioned by OSTC, Department of Ocean Development.

Economic viability of placer mining along the coast between Mandapam and Kanyakumari -Sanctioned by OSTC, Department of Ocean Development- Rs.11 lakhs.

Proposal under Processing

Sea Level Variataion and its impact along the coast between Kodiyakkarai and Parangipettai -Submitted to CMAAC, Bangalore for the cost of 41 lakhs.

A proposal for conducting refresher course on "Sea level variation studies" in summer 1999 has been put forward to UGC.

A. EQUIPMENT IN DEPARTMENT

Sl.No.	Name and Equipment	Model and Make
1.	Auto collimation, wild T2 Theodolite (Rs. 5 lakhs)	Wild Heerbrugg, SWITZERLAND
2.	Leitz Orthopol.research microscope complete with wild MPS 45 automatic photomicrographic system. (Rs.6 lakhs)	WEST GERMANY
3.	Satellite Imageries (Kanyakumari to Vizag coastal area) 6 Nos.	NRSA, HYDERABAD
4.	Prism Stereoscope	Optomach, HYDERABAD
5.	Mirror Stereoscope	National Instruments, Madras
6.	Acid Digestion Bombs (2 Nos. each costing $ 250	Part Instruments Co., U.S.A.
7.	U.V.Visible spectrophotometer with Printer (Rs.2 lakhs)	GBC Scientific Company AUSTRALIA
8.	Platinum dish (0.64 lakhs)	Mahalakshmi Scientific Co.,TRICHY
9.	Resistivity meter	Terra Science, INDIA
10.	Isodynamic Separator (Rs.3.5 lakhs)	Chas W.Cook, England (imported)
11.	Galen III (Leica) Trinocular research microscope (Rs. 1.5 lakhs)	WEST GERMANY
12.	Atomic Absorption Spectrophotometer	GBC, Australia
13.	One Pentium - II Processor Windows NT based Server (333 MHz), 128 MB RAM, 9.1 GB HDD, 1.44 FDD, 24 X CD ROM Drive, 14" SVGA Colour Monitor, 4 GB DAT Drive	

Two Celeron Stand alone Systems - 300 MHz
128 MB RAM, 4.1 GB HDD, 1.44 FDD,
14" SVGA Colour Monitor

Four Nos. of Intelligent Nodes: each with
Cyrics 300 MHz Processor, 16 MB RAM
1 GB HDD, 1.44 FDD and usual accessories.
Four 14" SVGA coloured monitors.

a. Full multi media kit
b. One HP Laser Printer
c. One ink - Jet Printer
d. Four Dot Matrix Printers
e. One 2 KVA UPS
f. One colour scanner
g. Power Generator

14. 64 KB Leaseline From VSNL for Internet

Completed Projects/Ongoing

Investigator	Project Title	Status	Duration	Total	Name of the funding Agency
1.	2.	3.	4.	5.	6.
G.Victor Raja-manickam	OFFSHORE ILMENITE PLACERS ALONG KONKAN COAST	Completed	1974-1985	Approxi-mately 60 Lakhs	Council of Scientific and Industrial Research, New Delhi.

High Lights : The presence of offshore placer mineral of ilmenite and magnetite has been confirmed. The completion of this project has developed a confidence and expertise for mining of offshore placers in our country.

Investigator	Project Title	Status	Duration	Total	Name of the funding Agency
G.Victor Raja-manickam & V.J.Loveson	FINDING ANCIENT SHORELINES ALONG THE COAST BETWEEN MANDAPAM AND KANYAKUMARI	Completed	1986-1989	1.5 Lakhs	University Grants Commission New Delhi.

High Lights : Identified three terraces and inferred the ancient shoreline. These shorelines evolved due to the different marine transgressions and regressions in the recent past.

Investigator 1.	Project Title 2.	Status 3.	Duration 4.	Total 5.	Name of the funding Agency 6.
G.Victor Raja-manickam & Y.Subbarayalu	MARITIME HISTORY OF SOUTH INDIA	Phase-I Completed in 1991 Phase-II Completed IN 1991	1987-1991	10 Lakhs	Council of Scientific and Industrial Research, New Delhi.

High Lights : The project finding suggests that the traditional boats characterise the region and the nature of the sea conditions. The method of ship building without using any nail, the bending of planks, the designing of the boat, etc., characterise the traditional technology.

G.Victor Raja-manickam	RECONSTRUCTION OF ANCIENT CRUCIBLE TECHNOLOGY THROUGH EXCAVATIONAL FINDING FROM MEGALITHIC SITE FROM KODUMANAL, SALEM TAMIL NADU	Completed	1988-1990	3 Lakhs	University Grants Commission, New Delhi.

High Lights : Identified different ancient crucible technology and compared with modern technology.

G.Victor Raja-manickam	BEACH PLACER MINERAL EXPLORATION ALONG THE COAST BETWEEN MANDAPAM AND KANYAKUMARI	Completed	1989-1992	5.89 Lakhs	Department of Ocean Development, New Delhi.

High Lights : Two major zones of heavy mineral placer concentration suitable for mining are identified.

G.Victor Raja-manickam	HEAVY MINERAL DIS-TRIBUTION FOR BORE-HOLE SAMPLES FROM THE OVER BURDEN AND UNDER BURDEN THE LIGNITE SEAMS	Completed	1989-1994	2 Lakhs per year	Neyveli Lignite Corporation Ltd., Neyveli, Tamil Nadu.

High Lights : More than 229 borehole samples of Cuddalore sand stone have been analysed and the constituent non-opaque heavy mineral are identified. The analyses of Rajasthan and Gujarat lignite beds samples were analysed and Stratigraphic correlation were made.

Investigator 1.	Project Title 2.	Status 3.	Duration 4.	Total 5.	Name of the funding Agency 6.
G.Victor Raja-manickam	EVALUATION OF THE PERFORMANCE OF SOUTH INDIAN STUDENTS IN NET	Completed	1993-1996	13 Lakhs	Department of Science & Technology, Govt.of India, New Delhi.

High Lights : Students performance in NET examinations are poor in South India. This is mainly of poor motivation among students, teachers care to the students and the syllabus.

G.Victor Raja-manickam	EVOLUTION OF QUATERNARY LANDFORMS BETWEEN VEDARANYAM AND RAMESHWARAM EAST COAST OF INDIA	Completed	1994-1997	11.4 Lakhs	Department of Science & Technology, Govt.of India, New Delhi.

High Lights : Different geomorphological landforms are identified and its evalution, sedimentry textures and heavy minerals are studied and inferred that similar to the present day offshore processes are the causes for development of above said landforms.

P.M.Mohan & G.Victor Raja-manickam	IDENTIFICATION OF COASTAL PLACER MINERALS ALONG THE COAST BETWEEN MADURANTAGAM AND MADRAS	Completed	1995-1998	3 Lakhs	Department of Science & Technology, Govt.of India, New Delhi.

High Lights : Pondicherry to Chennai coast has been studied for the burried placer deposits and identified the same. The deposits may be available to the dune of 2 - 21 MT of illmenite and magnetite.

G.Victor Raja-manickam	THE TRADITIONAL NAVAL ARCHITECTURE AND IMPACT OF EUROPEAN INFLUENCE 16-18 A.D.	On going	1997-1998	2.5 Lakhs	INSA, New Delhi.
G.Victor Raja-manickam	QUANTIFICATION OF FINANCIAL AND MAN-POWER RESOURCES DEVOTED TO RESEARCH AND DEVELOPMENT IN SCIENCE AND TECHNOLOGY FROM ACADEMIC SECTOR-SOUTH ZONE.	On going	1998-2000	30 Lakhs	Department of Science & Technology, New Delhi.

Investigator 1.	Project Title 2.	Status 3.	Duration 4.	Total 5.	Name of the funding Agency 6.
G.Victor Raja-manickam & K.V.Balasubra-manian and B.Sidharthan	A TECHNICAL DICTIONARY FOR EARTH SYSTEM SCIENCES (ENGLISH-TAMIL)	On going	1998-2001	2.6 Lakhs	University Grants Commission, New Delhi.

Recent Scientific Publications from 1996 - International

S.No. 1.	Year 2.	Title of the Paper 3.	Journal 4.	Pages 5.
1.	1996	The Ship-building Technology:As Practised in Beypur, Kerala.	Ship Building and Navigation in the Indian Ocean Region AD 1400-1800	44-54
2.	1996	The Race Boats of Kerala and their Tradition - Some Observation	"	55-61
3.	1996	Neogene-Quaternary formations around Sathankulam, Southern Tamil Nadu	Proceedings of the First Regional GEOSAS Workshop on Quaternary Geology of South Asia	52-63
4.	1996	A Synoptic view of Quaternary sediments and their importance to natural resources	Proceedings of the First Regional GEOSAS Workshop on Quaternary Geology of South Asia	257-275
5.	1997	Provenance of the sediments inferred from transparent heavy minerals on the inner shelf of Central Maharashtra	Proc. of Second South Asia Geological Congress (GEOSAS-II), Sri Lanka.	309-323
6.	1997	Zircon placer deposits along the beaches of central Tamilnadu, India (with N.Chandrasekar)	Proc. of Second South Asia Geological Congress (GEOSAS-II), Sri Lanka.	337-348

S.No. 1.	Year 2.	Title of the Paper 3.	Journal 4.	Pages 5.
7.	1997	Ilmenite placer deposits in the bays of Jaigad, Ambwah and Varvada, Maharashta, India (with O.P.Varma and A.R.Gujar)	Proc. of Second South Asia Geological Congress (GEOSAS-II), Sri Lanka.	325-336
8.	1999	Light Heavy minerals on the Indian Continental Shelf, including beaches	CRC Press, London	In Press
9.	1999	Grain size distribution of beach sediments along central Tamilnadu (with N.Chandrasekar)	IGCP-274 Proc.Vol. New Academic and Law Serials, New Delhi.	In press
10.	1999	Geomorphology and evolution of the east coast from Kanyakumari to Mandapam, Tamilnadu (with V.J.Loveson)	IGCP-274 Proc.Vol. New Academic and Law Serials, New Delhi,	In press
11.	1999	Preliminary Geomorphological Investigations in and Around Northern Tamilnadu Coast (with K.Anbarasu)	"	In press

Research Publications from 1996 - National

S.No. 1.	Year 2.	Title of the Paper 3.	Journal 4.	Pages 5.
1.	1996	Results of the priliminary investigations on the performance of students in NET from southern Universities (with P.M.Mohan, P.Udayaganesan, I.Baskar, V.Ganesan and M.Jothilakshmi) (Eds. S.Arunachalam and G.Victor Rajamanickam)	Science Indicators Published by Tamil University, Thanjavur	122-135
2.	1996	Do our educational centers in rural areas produce science and technology manpower? (Eds. S.Arunachalam and G.Victor Rajamanickam)	"	40-44

S.No. 1.	Year 2.	Title of the Paper 3.	Journal 4.	Pages 5.
3.	1996	Economic Viability of Manganese Nodule mining in India:a discussion (with S.Manickam and R.E.Benjamin)	Journal of Geological Society of India, Vol.48, No.3	331-339
4.	1996	Coastal placer development and environmental mangement (Eds. S.Z.Qasim and G.S.Roonwal)	Indias Exclusive Economic Zone-Resource, Exploitaiton and Management Omega Scientific Publishers	65-73
5.	1996	Distribution of Organic Matter and Calcium Carbonate Content in the Sediments of Saltmarsh Area, Tuticorin, Gulf of Mannar (with N.Chandrasekar, V.J.Loveson)	Jour.Indian Asso.Sed.,V.15	59-67
6.	1996	Is our coast free from the impact of coastal mining?	Souvenir and Keynote Lectures, published by School of Studies in Earth Sciences, Jiwaji University, Gwalior	21-35
7.	1996	Petrography of coastal basalts from the northern Konkan region, Maharashtra, India(with O.P.Varma and A.R.Gujar) (Eds. O.P.Varma and G.Victor Rajamanickam)	Proceedings of the IGC National Seminar IX Convention published by the Indian Geological Congress,Roorkee	140-149
8.	1996	Opaque minerals distribution in in the coastal basalts, Ratnagiri district, Maharashtra, India (with O.P.Varma)	Proceedings of the IGC National Seminar IX Convention published by the Geological Congress,Roorkee	95-102
9	1996	A study of light minerals in the Gadilam river basin, Tamil Nadu (with N.Muthukrishnan)	"	27-38
10.	1996	The distribution and nature of transparent heavy minerals along the southern Tamil Nadu coast (with N.Angusamy)	"	38-44

S.No. 1.	Year 2.	Title of the Paper 3.	Journal 4.	Pages 5.
11.	1996	Grain size distribution and depositional environment of the Vaippar river sediments, Tamil Nadu (with P.Udayaganesan)	"	44-53
12.	1996	Soil water degredation due to tidal water ingress in Ennore coastal tract, Madras city, Tamil Nadu (with K.Shepherd and Sp.Subramaniam)	Proceedings of the IGC National Seminar, IX Convention published by the Indian Geological Congress, Roorkee	246-252
13.	1996	Manganese nodule industry : its systems systems and risks (with S.Manickam)	"	85-95
14.	1996	Estimates of Indian market for manganese nodule metals (with S.Manickam)	"	102-109
15.	1996	Geochemistry of beach sediments of central Tamil Nadu (with N.Chandrasekar)	"	259-267
16.	1996	Littoral sediments transport along the southern Tamil Nadu coast (with N.Chandrasekar)	"	60-64
17.	1996	Usefulness of identifying different geomorphic blocks along the coast of southern Tamil Nadu (with V.J.Loveson and N.Angusamy)	Ind.Jour.Geomorph., Vol.1, No.1	97-111
18.	1996	Coastal plain environment of southern Tamil Nadu - as viewed from remote sensing technique(with V.J.Loveson)	"	111-124
19.	1996	Catamaran in South Kerala :A Study of Constructional Techniques (with A.P.Greeshmalatha)	History of Science, Vol.30,	1-10
20.	1997	Grain size studies on the nearshore sediments of Jaigad, Ambwah and Varvada bays, Maharashtra, India (with A.R.Gujar)	Jour.Geol.Soc.Ind., Vol.49	567-576

S.No. 1.	Year 2.	Title of the Paper 3.	Journal 4.	Pages 5.
21.	1997	Traditional Ocean Knowledge prevailing among the tribes of Andaman & Nicobar Islands	Hist.of Sci.,Vol.32.	29-46
22.	1997	Abandoned Channels of Rivers - An Evidence for Neotectonism (with K.Anbarasu)	Ind.Jour.Geomorph., Vol.2, No.2	209-217
23.	1998	Wave refraction pattern and its role in the redistribution of sediments along the southern coast of Tamilnadu (with N.Angusamy and P.Udayaganesan)	Indian Jour.of Marine Sciences V.27.	173-178
24.	1998	Heavy mineral distribution and provenance of Vaippar river sediments, Tamilnadu (with P.Udayaganesan and N.Angusamy)	"	179-184
25.	1998	Depositional environments:Inferred from grain size along the coast of Tamilnadu (with P.M.Mohan)	Jour.Geol.Soc.Ind.	95-100
26.	1998	Coastal geomorphological assessment for evaluating supportive capacity of southeastern Coromandal coastal zone: A remote sensing approach (with V.J.Loveson)	Ind.Jour.Geomorphology, Vol.2	1-16
27.	1998	Heavy metal concentration in salt marsh sediments off Tuticorin coast (with N.Chandrasekar, V.Sivakumar and A.V.Udayanapillai)	Ind.Assoc.of Sedimentologists	
28.	1999	Distribution of Heavy Minerals along the Beach from Mandapam to Kanyakumari (with N. Angusamy)	Jour.of Geo. Soc.India	In Press
29.	1999	Beach Morphology and the inferences from Heavy Mineral assemblage of Mandapam to Kanyakumari Coast, Tamil Nadu (with N.Angusamy)	Ind.Jour.Mari. Sci	In Press

S.No. 1.	Year 2.	Title of the Paper 3.	Journal 4.	Pages 5.
30.	1999	Grain size texture and depositional environment along the coast between Vedaranyam and Rameshwaram, Tamil Nadu (with P.M.Mohan, K.Shepherd, N.Angusamy, M. Suresh Gandhi and G.V. Rajamanickam)	Geol.Soc.of India	In Press
31.	1999	Buried placer deposits of Northern Tamil Nadu Coast from Madras to Pondicherry (with P.M.Mohan)	Geol.Soc.of India	In Press
32.	1999	Geomorphic Evolution of Rameswaram Island, South India (with V.J.Loveson)	Ind.Jour. Geomorphology	In Press
33.	1999	Coastal Erosion Around Pondicherry and Ennore, East Coast of India (with K.Anbarasu)	Geol.Soc.of India	In Press
34.	1999	Quaternary Sea Level Changes Along East Coast of India (with K.Anbarasu)	Ind.Jour.of Geomorphology,	In Press

STAFF AND SCHOLARS DEPUTED FOR TRAINING

Dr.N.Angusamy

Cruise Experience Participated in the **Sagarkanya** scientific cruise from December 3rd-30th, 1996 from Paradeep to Goa.

Participated in the **Senckenberg** scientific cruise from North Sea to Baltic Sea, Wihelmshaven to Rugen island, Germany from July, 1-20, 1998.

Participated in the scientific cruise **RV Hunde** from Helgoland to Cuxshaven, Germany in North Sea from July 22-30, 1998.

Participated in the scientific cruise **RV Hunde** from August 1-5, 1998.

Special Training Received

Attended familiarisation of x-ray diffractometric course held in National Institute of Oceanography, Goa, during February 3-10, 1990.

Participated in the mineral deposits modelling course organised by Indian School of Mines, Dhanbad, December 5-10, 1992.

Participated in a training course on documentation of traditional vessel building and allied techniques with Prof.McGrail of Oxford University, during February, 1994.

Participated in the advanced structural mapping of supracrustal rocks organised by Geological Survey of India, Hyderabad, during October 3 to November 1, 1994.

Participated in the training course on Deep Sea Bed Mining from July 15th to August 15th, 1996 organised by Ocean Engineering Centre, IIT, Chennai.

Participated in the training course on Geographic Information System (GIS) organised by University of Hamburg from April 1-9, 1998.

Participated in the training course on Envrionmental Impact Assessment organised by University of Hamburg, from April 15-30, 1998 at Hohenwestedt, Germany.

Particpated in the Introductory Training Course on Running the Linux, an Unix based software, at Forschung Research Institute, Wilhelmshaven, Germany, June 1998.

Participated in the training course on Protection of Environment from the Oil Spil in North Sea in Burnsbuttel, Kiel, Germany from April 1-15, 1998.

Visited Alfred Wegner Institute for Polar Research in Cuxshaven, Germany on to know their research activities in Antartica and marine fields.

Participated in the training workshop on Ground Improvement held at Department of Civil Engineering, Shanmuga College of Engineering, Thirumalaisamudram, Vallam, Thanjavur from 26-28 November, 1999.

Dr.P.M.Mohan

Participated in four Seminars and three Workshops and two Brain Storming Session.

Participated in a International Course on "Modern Technologies for Mineral Resources Assessment and Management" during the period of December 20, 1995 to January 13, 1996, held at Department of Earth Sciences, University of Roorkee, Roorkee - 247 667, India.

A practical experience was obtained (two weeks) in GIS (Geographical Information System) and GPS (Global Positioning System) during the International Course on "Modern Technologies for Mineral Resources Assessment and Management".

Participated in Department of Science and Technology sponsored 17th Group Monitoring Workshop for the assessment of DST - Scheme for Young Scientist Project during the period of September 26 and 27, 1996, held at CAS in Geology, Panjab University, Chandigarh, India.

Assisted to the Head of Department, for organising different International/National Seminar/Workshop/Symposium in Department of Industries and Earth Sciences, Tamil University (15 Nos.).

Participated a workshop on "Patent Awareness" held at Meenakshi College for Women, Madras, on 23.01.98.

Participated a short course on "Active Tectonics and Paleoseismology" during the period of September 14-19, 1998, held at JNCAS, IISc. Campus, Bangalore, India.

Dr.M.Suresh Gandhi

Cruise Experience

Participated in the ORV Sagar Kanya (Department of Ocean Development) Cruise off Bay of Bengal for the collection of core sampling as well as geophysical surveys in basinal and non-basinal areas for 2 months.

Seminars Attended

Participated in the International Conference on PACEM IN MARIBUS (PIM) XXII, held at Indian Institute of Technology, Madras from 4-8 December,1994.

Participated in 5th Scientific Tamil Conference, held at Annamalai University, Chidambaram, 5-7 June, 1997.

Participated in the Training Workshop on the Quaternary mapping in the Bengal Basin held at Bose Institute Calcutta from 4-9 January, 1999.

Invited Talk Delivered a lecture on the Impact of Siltation in the Benthic Foraminiferal Distribution Along Palk Strait, Tamil Nadu, by the invitation of Environmental and Remote Sensing Cell, Geography Department at Rajshahi University, Bangladesh.

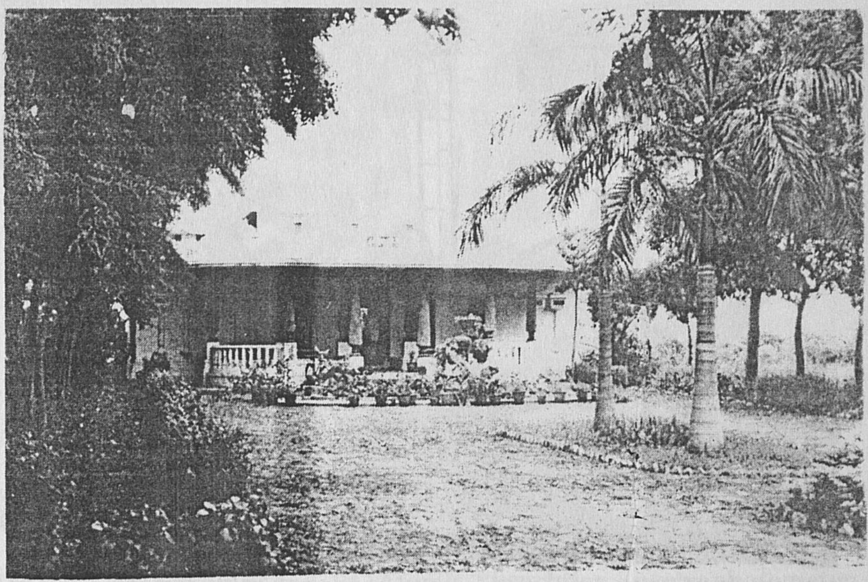
Mr.R.Karikalan

Cruise Experience Participated in the **Sagarkanya** scientific cruise from December 3-30, 1996 from Paradeep to Goa.

Special Training Received Participated in the training workshop on Land Slide Hazards held at Department of Earth Sciences, Roorkee University, Roorkee (U.P.) from 24-25 April, 1998.

Participated in the training course on Remote Sensing Application to Marine Environment and the project entitled "Remote Sensing Applications for Bathymetry Studies off Bhavnagar, Gulf of Cambay, Gujarat Coast" at Indian Institute of Remote Sensing, NRSA, Dehradun (U.P.), from January 5-March 27, 1998.

Participated in the training workshop on Ground Improvement held at Department of Civil Engineering, Shanmuga College of Engineering, Thirumalaisamudram, Vallam, Thanjavur from 26-28 November, 1999.

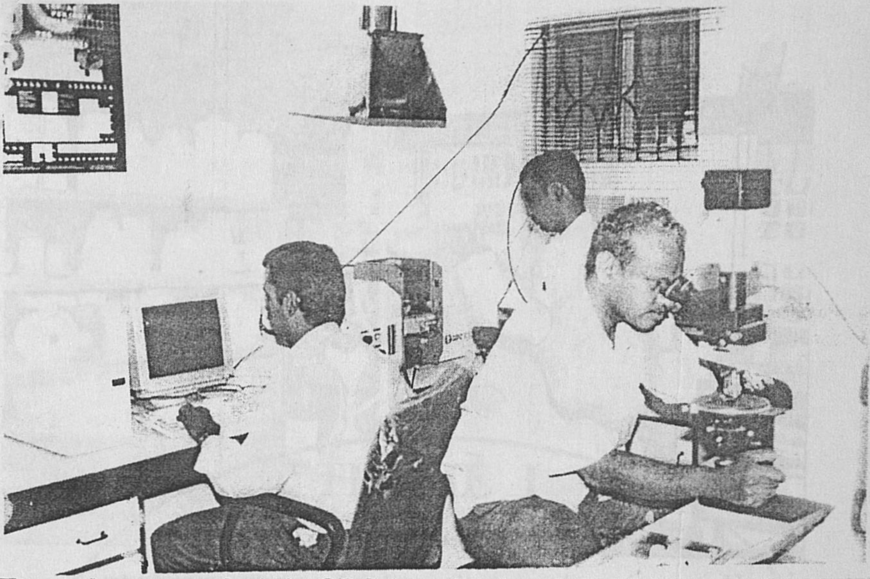


Ocean Science and Technology Cell (OSTC)

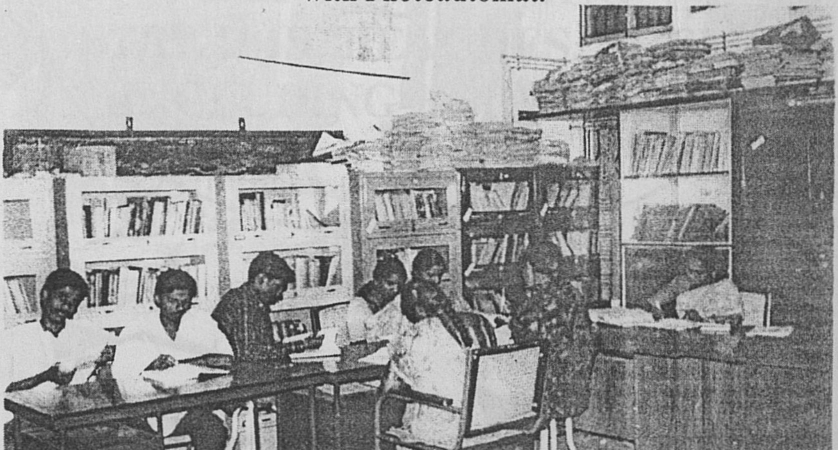
Computational works in Pentium II Processors

Vanishing Traditional Boat Models of South India

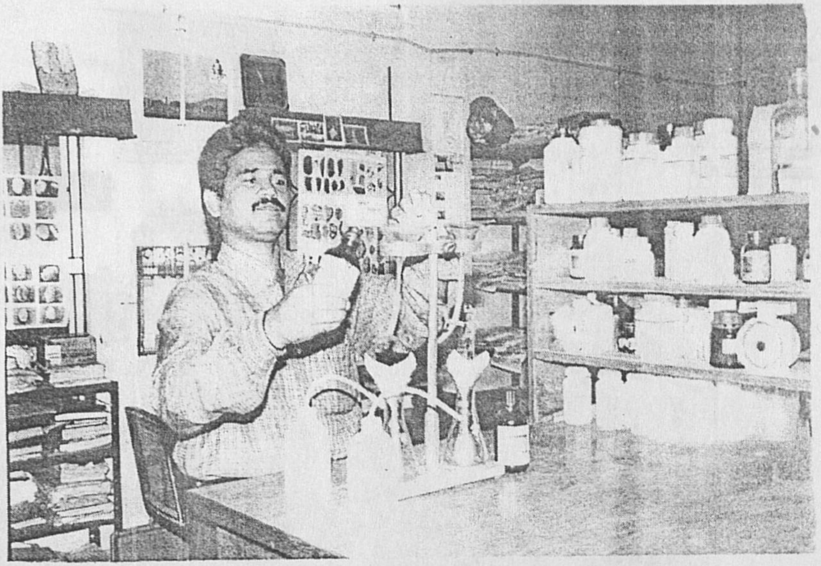
Separation of magnetic minerals using Cook Isodynamic separator



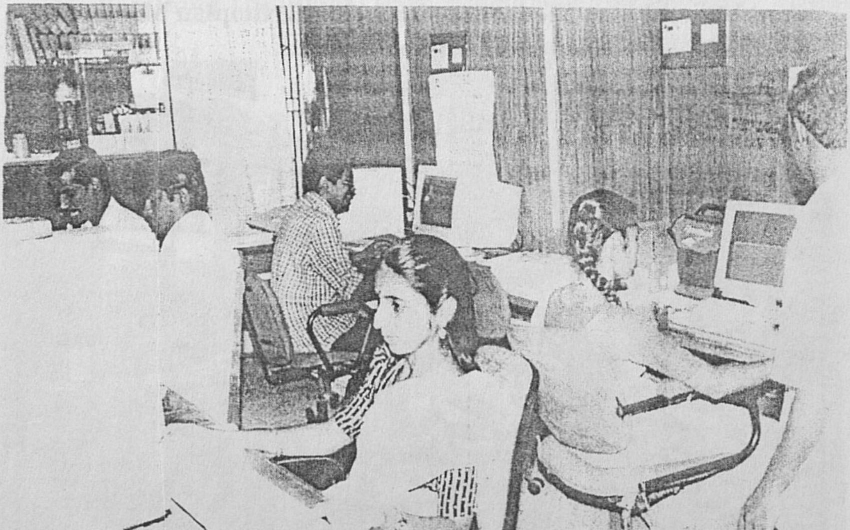
Trace element analysis in GBC Atomic Absorbtion Spectrophotometer and Mineral identification under Leitz -Orthoplan Microscope with Photoautomat.



Scholars using the Library



Heavy mineral separation using bromoform technique



Publication and Research works in progress with using of HP Colour Scanner, HP Colour Deskjet and HP Laserjet

THEME I

EXPLORATION OF PLACER DEPOSITS ALONG STREAMS, BEACHES, SHELF INCLUDING BURIED, Etc.

BEACH PLACER DEPOSITS OF ORISSA

B.C. Acharya and S.K. Das
Regional Research Laboratory, Bhubaneswar - 751 013, Orissa.

The occurrence of heavy minerals in beach sands of Orissa coast is well known. The economic placer deposits are however, restricted to a number of small pockets. A stretch of about 150 km from Konark to south of Gopalpur have a number of potential deposits varying in heavy minerals from 5 to 30 %. The Gahiramatha coast (between Hansua and Dharma rivers) too contain rich heavy mineral deposits. Among these, the Chatrapur coast extending 18 km between Rushikulya river and Gopalpur with an average width of 1.5 km is very important from the point of view of both grade and reserve. The other promising deposits include Pedalaximpuram-Ramayapatana, Ramayapatana-Markandi, Niladripur-Kantiagarh, Jhatiapadar, Arunpur, Pallur, Prayagi, Mayurpada in Ganjam district: Paikarpur and Nandala in Puri district: and Gahiramatha coast in Kendrapara district which requires further study.

Ilmenite, garnet, sillimanite, rutile, zircon and monazite are in the decreasing order of abundance. The other associated heavy minerals are hematite with trace amounts of magnetite, hornblende, diopside, sphene, tourmaline and epidote. The heavy minerals are mostly concentrated below 3.55 m. Microscopic observation revealed that some of the ilmenite grains contain hematite exsolution. Besides, exsolution lamellae of ilmenite within hematite are also noticed. Alteration of ilmenite to leucoxene and anatase along fractures and margins are distinct in some cases.

EPMA studies have established the mineral chemistry of ilmenite, hematite, leucoxene, rutile, etc. Besides titanium and iron, the ilmenite phase contains Al, Mg, Ca, Mn, Cr, Zn, V and Ba. It is interesting to mention that the hematite phase intergrown with ilmenite contains higher amounts of titanium in addition to small amounts of Al, Mg, Mn, Cr, V, Zn, Ba and Si. The higher amounts of TiO_2 in hematite may be due to the solid solution of Fe_2O_3 and $Fe TiO_3$. The altered leucoxene is enriched in Ti, Si, Al, Cr, V and depleted in Fe compared to the ilmenite phase.

The implications of texture and the mineral chemistry data in mineral processing are discussed in the paper. Khondalite, charnockite, calc-silicate granulite, leptynite, migmatite, gneiss, basic granulite and pegmatite of the Eastern Ghats which contain heavy minerals as accessories appear to be the source of heavy minerals. The heavy minerals were carried by the rivers to the coast where wave velocity, littoral currents etc. have played important roles in sorting and concentrating the heavy minerals into economic beach placer deposits.

EXPLORATION, EVALUATION AND DEPOSITIONAL CHARACTERS OF HEAVY MINERALS IN BEACH PLACER SANDS OF KAYAMKULAM BARARATTUPHUZHA TRACT, KERALA, INDIA

K.Balachandran*, T.S.Shaji*,
G.Viswanathan* and S.Krishnan**
Atomic Minerals Directorate for Exploration and Research
Department of Atomic Energy
*Poojapura, Trivandrum-695 012, Kerala. **Begumpet, Hyderabad-500 016, A.P.

The Neendakara-Kayankulam heavy mineral bearing placer deposit known popularly as 'Chavara deposit' is rated as one of the best in the world owing to its unique mineralogical assemblage, vast resources of 125 million tones and altered ilmenite/leucoxenised chemical characters, of contained 61% TiO_2 in ilmenites, well above the stoichiometric value. The extension of similar geological and geomorphological environments further north in Alappuzha district of Kerala called in for intensive exploration inputs to confirm the continuity of viable mineralisation. An area of 3.98 sq.km over 10 Line km along the coastal stretches of Kayankulam Bararattupuzha tract was explored with the exploration inputs of 191 bore holes aggregating 1890 m of drilling, generating 1281 individual samples. The provenance, it is seen, is not so different from Chavara-Khondalites, reworked Tertiary sediments and laterites-as reflected by identical mineralogical assemblage. This deposit holds sizeable heavy mineral reserves of 6.27 million tonnes at an average grade of 10.35% by weight of which ilmenite constitutes 3.87 million tonnes (61.8% of the total heavy mineral reserves). Sillimanite (27.25%), rutile (3.43%), leucoxene (2.96%), zircon (2.51%), garnet (0.81%), kyanite (0.45%), and monazite (0.32%) follows the suite. TiO_2 content of ilmenite ranges from 61.46 to 63.98%.

The major heavy mineral reserves of 3.75 million tonnes at an average grade of 23.19% upto 9.0 m explored depth, confined to the beach blocks i.e., within 125 m from the shoreline is the reflection of Chavara wherein higher concentrations are confined to the barrier beaches normally of the said width. This depositional character can be well defined by the frequency

distribution of heavy mineral grades of individual bands which exemplifies that the samples upto the depth of 6.0 m are mixed in nature. The high-grade fractions (of 30-50% THMs) are mixed with the insitu palaeo placers with inherent heavy mineral concentration of 6% by geological and geomorphological processes. These in-situ palaeo placers between 6.0-9.0 m show a perfect normal distribution, overwhich high grade placers, as stated, showing polymodality have been deposited. The variograms for different depth zones also substantiate this view point.

The major implications on the basis of this model are the positive trends for cyclic changes in sedimentation and possible existence of concealed palaeo beaches-series of strandlines with viable heavy mineral concentrations, that can be confirmed by the application of planned inputs.

ILMENITE-RICH BEACH PLACER SANDS IN THE RAJAKKAMANGALAM-PALLAM AREA OF KANYAKUMARI DISTRICT, TAMILNADU

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Ilmenite dominant placer heavy mineral concentrations upto 35% occur in the unconsolidated, fine to medium beach and dune sands in the form of two linear bands over a stretch of 3,800 m paralleling the East-West trending shoreline. Ilmenite constitutes 63% of the heavy minerals followed by sillimanite (18%), zircon (6%), garnet (4.4%), rutile (3%), monazite (1.2%) and magnetite (0.3%). Predominance of sillimanite over zircon and garnet in the heavy mineral suite contrasts with the nearby Manavalakurichi beach placer deposit where garnet is the most abundant mineral after ilmenite. Mineralisation is observed from the surface to a depth of 10.5 m in both the bands and is traceable over an area of 2000 m x 100-499 m and 3800 m x 100-400 m with an average total heavy minerals (THM) of 10.3% and 5.5% respectively.

Some ilmenites have been altered to leucoxene, the latter comprising 3.8% of the THM. Most of the ilmenites are only partially altered and contain 54.02-56.36% TiO_2 with higher FeO (20.58-34.50%) than Fe_2O_3 (7.69-20.57%). Cr_2O_3 ranges from 0.02-0.07% and that of V_2O_5 from 0.12-0.24%. The raw sand has a primary mode of -420+250 microns. The heavy minerals as a class is finer, ilmenite and sillimanite have primary mode of -149+125 microns and those of rutile, zircon and monazite have -105+74 microns; garnet is coarser with primary mode at -420+250 microns. The heavy minerals are suitable for industrial recovery.

The placer sand has a moderate slime content of (10.5%) and low shell content (6%). The heavy mineral reserves are estimated at 2.98 million tonnes in the indicated category at an average grade of 5,74% and thickness of 8 m and could serve as an additional source for the existing heavy mineral separation plant at Manavalakurichi.

EXPLORATION FOR PLACER GOLD IN THE VEPPANAPALLI AREA, DHARMAPURI DISTRICT, TAMIL NADU

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The Veppanapalli area forms the southern extension of the north-south trending Kolar Schist Belt into Tamil Nadu. The Kolar Schist Belt is known for its gold potential. The Veppanapalli, Nachikuppan and Markanda nadhis which flow through the area cutting across a part of the Kolar Schist Belt. The Veppanapalli area was selected for the present study, since the rivers passing through the plains of Veppanapalli area are draining the well known gold bearing Schist Belt.

Boseworth Smith (1889) was the first to mention about the panning of gold at various places along the Veppanapalli nadhi. Suthanandam et al., (1987) carried out reconnaissance survey for placer gold in the Veppanapalli area, newer alluvium along the Veppanapalli nadhi and older alluvium of Dasiripalli area. They also reported 0.034 g/cu.m. of placer gold in a pit near Sigaramanganapalli village.

The quaternary deposits noticed in the study area include paleo-flood plains, fluvio-colluvial material, paleo- channel, paleo-terraces, depositional terraces, buried channels, point bars and channel bars. Three depositional (newer) terraces were identified along the present day river courses. All the three terraces are fairly, extensively developed. Apart from these a large number of channel bars, point bars, buried channels, and paleo-channels have been identified along the course of the rivers, but their areal extent is very limited. The thickness of alluvium ranges from 1.5 m to as much as 6.00 m.

Gold is disseminated in thin layers/zones in different sections - of the alluvial column with intervening barren sections. Pitting and sampling work was carried out using 'Caissons' and 'long Tom' units. Gold occurs as specks, dust and flour. Thickness of gold bearing zone ranges from 0.1 m to

2.63 m and most of the zones are less than 1.00 m thick and the ratio of the zones with 0.01 g/cu.m. (cut-off) or more of gold to the total thickness of alluvium exposed in pits ranges from 1:1.1 to 1:4 for different quaternary deposits. In general, the zones with more than 0.01 g/cu.m. of gold occur below a depth of 1.5 m and associated with pebbly sand layers. The gold values increase with increasing grain size of the pebbles/sand and higher gold values are generally obtained from near the bedrock.

The detailed mapping indicates, a few locations of placer gold concentration viz., younger terraces, point bars and channel bars. The total alluvial resources of the area comprising of 68% of order alluvial material and remaining 32% is in the reworked newer alluvium. The maximum gold content of samples is 0.087 g/cu.m. The average grade of placer gold at a cut-off 0.01 g/cu.m ranges from 0.01 g/cu.m. to 0.0352 g/cu.m. and the average grade for the material in the various quaternary sediments is about 0.002 g/cu.m. for the younger sediments, which have a limited areal distribution and about 0.017 g/cu.m. for the older units, which have a more extensive areal distribution.

A cut-off grade of 0.05 g/cu.m. was arrived at by Eoin MacDonald, the U.N. consultant for Kerala Mineral Exploration and Development project, Government of Kerala for placer gold mining in Nilambur area in 1981. As the gold price has become manyfold during the past 18 years, a cut-off grade of 0.03 may be economically viable at present. In view of this, the gold placer deposits of Veppanapalli area can be exploited economically.

GEOMORPHOLOGICAL CONTROL AND SIGNIFICANCE IN BEACH PLACER EXPLORATION

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The geomorphic control and significance, geographical location, stratigraphic disposition, lithology, depositional setting, paleogeographic distribution and the provenance of the source of heavy mineral deposits are to be clearly understood and discerned while formulating beach placer exploration programme. As the geomorphic landforms are mute attestation of the processes and the lithology in an area, the detailed mapping of the various geomorphic landform units are essential and to be supplemented by aerial photographs and satellite imageries.

As placer deposits are mainly confined to the river mouths, deltaic areas and coastal stretches, the detailed geomorphic mapping of the fluvio-marine landforms is essential. Heavy mineral placers are reported to be concentrated by a number of processes and are widely distributed through the coastal sands. The fluvial currents, marine waves, wind currents and longshore currents play a major role and the longshore currents are the most important form of depositional control. For understanding the depositional environment and lithology, the detailed geomorphological mapping on various convenient scale, has to include precise demarcation of all the landform units, such as the strand plains and associated litho-facies, lower shoreface, middle shoreface, surf (upper shoreface), forebeach (foreshore), berm, dune, etc., supplemented by geophysical work. It has been observed that the quartzose sand in the strandplains/dunes form ideal nesting house for the heavy minerals to get locked up between the sand grains. The beach placers occur as elongated lenses, pockets, lumps almost parallel to the trend of shoreline, intercalated with the beach sands. The origin and evolution of the coast plays an important role. Any venture for beach placer exploration can be successful only with a basic detailed geomorphological map which is a prerequisite. A conceptual geomorphic depositional model has to be prepared.

HEAVY MINERAL STUDIES OF THE BEACHES BETWEEN BARUVA AND BAVANAPADU, ANDHRA PRADESH, INDIA

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The economic potentiality of the heavy minerals in the surface and subsurface sediments in the beaches over 45 km between Baruva and Bavanapadu was examined. In the sub surface sediments, the heavy minerals were studied at an interval of 1 m upto a maximum depth of 5.8 m. In general, the concentration of heavy mineral content increases from surface to sub surface in dunes and decreases in backshore and foreshore. The heavy minerals in surface and sub-surface sediments include mainly opaques, garnet, sillimanite and orthopyroxenes with minor amounts of amphiboles, zircon, etc., are concentrated more in finer fractions while some of the heavies like garnet and sillimanite are concentrated in coarser fraction. The estimated inferred reserves estimated suggest that the area can be commercially exploited.

BEACH MINERAL STUDIES BETWEEN BAVANAPADU AND KALINGAPATNAM, EAST COAST OF INDIA

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Heavy mineral studies from surface and subsurface sediments were carried out from Bavanapadu to Kalingapatnam over a distance of 45 km along the East Coast of India. The concentration of heavies were estimated in three size fractions i.e. +0.25, -0.25 to +0.123 and -0.0625 mm and in total sample from different beach environments viz, dunes, backshore, upper and lower foreshore. Heavies are enriched more in dunes and backshore than the foreshore. The concentration of heavies in total sample ranges from 11.09 to 53.34 (av.27%), 4.83 to 59.91 (av.27%), 7.21 to 47.98% (av.25%) and 4.3 to 32.35 (av.12%) in dunes, backshore, upper and lower foreshore respectively. The heavies are concentrated more in finer fractions (-0.25 to +0.125 and -0.125 to +0.0625 mm). The heavy mineral assemblage consists mainly of opaques, garnet, sillimanite and orthopyroxene with minor amounts of clinopyroxene, amphiboles, zircon, monazite, rutile, tourmaline, staurolite, kyanite, etc. The mineral assemblages suggest that they are mainly derived from khondalite and charnockite group of Eastern Ghat complex. The estimated inferred reserves indicate that the heavy minerals can be economically exploited.

PLACER DEPOSITS IN SOUTHERN KERALA COAST

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Heavy mineral concentrations have been estimated in Trivandrum district in order to understand distribution and occurrence of placer deposits. Sediment samples from Vamanapuram, Karmana and Neyyar river basins and also along the coastal belt from Varkala to Kovalam have been collected systematically for estimation of heavy mineral concentration. The results indicated significant anomalous zones of heavy minerals including radioactive minerals along the beach sector.

NEOPROTEROZOIC-PALAEOZOIC DIAMONDIFEROUS CONGLOMERATES, PANNA DIAMOND BELT, M.P.

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Diamondiferous conglomerates associated with Rewa Group of rocks and at the base of Bhander Group of rocks, delineated over a strike length of 40 km., constitute one of the most important sources of diamonds in the Panna Diamond Belt and have been mined since antiquity.

Diamondiferous Itwa conglomerate is the diamondiferous horizon associated with Itwa Sandstone Formation (Lower Rewa Sandstone). The conglomerates occurs in the form of a thin sheet over strike length of 30 km in the eastern part of the diamond belt with average thickness of about 60 cm with considerable pitching and swelling. Regional and detailed drilling as well as shaft and drives sinking in these conglomerate indicates prominent thickening along palaeochannels and average thickness all around. Regional drilling has indicated Hatupur, Itwan, Badera, Hirapur, Bhasura, Dia, Bhatawa, Tikuri, Rohania, Kilaura, Gajna and Bhawanipur blocks with thick conglomerate horizon. Detailed exploration in Hatupur blocks proved 0.45 million tonnes of conglomerate with incidence of 27.91 carats per 100 tonnes.

The conglomerate is extremely ill sorted with subangular and subrounded pebbles of vein quartz, jasper, chert, glauconitic sandstone, white sandstone and Palkawan shale set in an arenaceous matrix. The roundness of pebbles is suggestive of its short distance travel. The conglomerate is actively mined in Hatupur area. The percentage of gem variety diamonds from these conglomerates is much higher than Majhgawan mines. The diamonds recovered are octahedron, dodecahedron and Trisoctahedron. The colour varies from brilliant colourless to bluish, greenish and yellowish tinges. Industrial diamonds are also recovered from this conglomerate.

Jhiri conglomerate is observed in the form of a thin blanket at the base of Jhiri Shale Formation of Rewa Group of rocks from Majhgawan Mines in the west to Paharikhera in the east and beyond. Well known mines

of Mahuatola and Shahidan are located in this horizon and are being mined for hundreds of years. Regional drill holes in the Panna Diamond Belt indicate its average thickness at about 15 cm. A number of palaeochannels with thick conglomerate are also recorded. The conglomerate comprises granules of vein quartz, jasper, chert, and sandstone set in a silty clayey matrix; the size of clasts varies between 1 mm and 1.5 cm (average 2 to 4 mm).

Detailed drilling in this conglomerate in Shahidan block proved 0.27 million tonnes of conglomerate with diamond incidence of 23.80 carats/100 tonnes.

The conglomerate at the contact of Gahadra Sandstone Formation (Upper Rewa Sandstone) and overlying Simrawal Shale Formation (Ganugarh Shale) is called Gahadra conglomerate and occurs in the form of a thin blanket in the southern part of the diamond belt. The conglomerate has a very low incidence of diamonds and is not mined by local workers.

Regional as well detailed drilling in some selected blocks of the diamond belt highlights their potential as promising blocks for further exploration and mining.

The diamonds recovered from conglomerates show a high ratio of gem to off colour to industrial variety at 55:19:26 as compared to diamonds from Majhgawan Mines where the ratio is 38:40:22.

OCCURRENCE OF PLACER GOLD DERIVED FORM AURIFEROUS REEFS AND LATERITE OF NILAMBUR VALLEY, KERALA, INDIA

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The placer gold occurrence along the stream channels of Nilambur is known since a long time. Placers are in proximity with the auriferous reefs and laterites of Nilambur area distributed in different dendritic stream sediments of Chaliyar river system. Categorisation of the auriferous placers, their distribution patterns with reference to geomorphology and hydrological controls are discussed in this paper. The study reveals better concentration of gold confined to the channels of present day streams and detailed exploration work carried out indicates a probable reserves of 30 million cubic meters. Fineness of the gold grains is higher than that in the crystallines. The study also indicates the provenance for the placer deposits in this region is the Wynad hills.

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HEAVY MINERAL DISTRIBUTION ON THE MID-CONTINENTAL SHELF, OFF CAUVERY DELTA, SOUTHERN PART OF EASTERN CONTINENTAL SHELF OF INDIA

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Offshore sediment within 43 m to 115 m depth off Cauvery delta is anamolously sandy with a sand mean size 0.9 phi to 2.26 phi. The sand content varies from 56% to 98%, of which 2% to 84% are acid solubles, indicating a terrigenous sand facies with lower acid solubility to the north and carbonate sand facies with higher acid solubility towards south. Heavy mineral content is higher in the terrigenous sand (2.3% to 40.65%) than carbonate sand (0.03% to 2.96%). R-mode factor analysis of the heavy mineral content in weight percentage along with others measured parameters such as depth of occurrence, sand content, solubility and sand mean size illustrates four factors explaining 70% of the total variance. High loading of heavy mineral content, phi mean size, acid solubility and garnet content, having inverse relationship with total sand content in the first factor differentiates terrigenous sand facies from carbonate sand facies. The high loading of amphibole and pyroxene (prismatic grains with lesser specific gravity) with inverse relationship to ilmenite and monazite (equant grains with higher specific gravity) in the second factor corroborate to hydraulic fractionation by shape and density. The strong association of magnetite, zircon (that occur as fine grains) and phi mean size indicates selective transport by size and density in the third factor. The association of sillimanite, epidote, rutile with monazite, kyanite, consisting the minor suite of minerals, and their relative abundance in the carbonate facies points to the diffusion of major suite of minerals as a result of depletion of terrigenous sand. The carbonate sand of the shelf is controlled by the morphology as it occurs where the shelf is wider within 50 m to 100 m depths. The presence of ooids in the carbonate sand attests to its shallow water origin during the lower strand of the sea level. Textural coarsening of the terrigenous sand towards offshore direction indicates its reflect nature and could have been deposited also during the lowered strand of sea level, as prodeltaic sedimentation from Cauvery/Coleroon which have not influenced the sedimentation at present.

SRIKURMAM - A MAJOR HEAVY MINERAL BEACH AND DUNE SAND DEPOSIT ON THE EAST COAST OF INDIA

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A large placer mineral deposit of beach and dune sand origin has been identified along Srikurmam coast, Srikurmam district, Andhra Pradesh (Lat 18°12'48"& 18°20'56", Long 83°56'50" & 84°07'50"). The deposit with the richest average explored grade of 34% heavy mineral (HM) concentration on the eastern sea boards of India, spans over a coastal length of 21 km with the coastal zone comprising beach sands width ranging from 400 to 1200 m. Preliminary exploration studies have indicated garnet and ilmenite to be the predominant mineral with a reserve and grade of 11.13 million tonnes (37.09%) and 9.58 million tonnes (31.94), respectively. Distribution pattern of other economically important minerals in the heavy mineral suite are sillimanite 24.33% rutile 1.32 %, leuxocene 1.42%, monazite 0.24% and zircon 0.96%. The deposit is bounded by two major structural lineaments in the form of two prominent river systems viz. Nagavali to the south and Vamsadhara to the north. EasternGhat Mobile Belt (EGMB) rock types of the migmatitic origin sediemntary units of the Upper Gondwana sandstones and large exposures or red sediments on the western margins of the deposit forms the hinterland geology for the deposit. The major estuarine forming rivers and their catchment during Holocene period and the pre-concentrate for the heavy minerals during the formation of red sediments is thought to have helped in the development of the vast sand body constituting the heavy mineral reserve. The ilmenite quality with 51% TiO_2 content with low trace elements as Cr, V, P and the grades of garnet as represented by their grain size have vast potential for developing this mineral property into an independent deposit with suitable down stream industry.

HEAVY MINERAL CONTENT FROM THE INNERSHELF SEDIMENTS OFF THE SOUTHWEST COAST OF INDIA

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The heavy mineral content from the innershelf sediment off the coast between Paravoor and Kovalam has been studied with a view to assess the provenance of the sediments and factors controlling the mineralogical variation of this region.

Total heavy mineral content of the innershelf ranges between 1.89% and 9.88%. High concentration of total heavy mineral is found off Kovalam promontory. Ilmenite and Sillimanite are the chief constituents of the heavy minerals. Other prominent heavies are garnet, rutile, monazite, zircon, hornblende, pyroxene, kyanite and muscovite. Ilmenite predominates very much over magnetite within the opaque group. In general, all heavies show a decreasing trend offshore. Garnet, sillimanite, monazite and zircon are found concentrated on southern region whereas other heavies are concentrated on northern region. Monazite up to 19.5% has been observed in the southern extremity.

Based on mineral ratio (varietal) study, an attempt has been made in identifying the controlling factors for heavy mineral concentration. Detrital garnet geochemistry has been dominated by almandine followed by pyrope and andradite. These have been derived from the rocks of the hinterland whereas the presence of the uvarovite points to a more distant source.

A PRELIMINARY APPRAISAL AND ECONOMIC POTENTIAL OF PLACER GOLD OCCURRENCE IN KRISHNAGIRI AREA, DHARMAPURI DISTRICT, TAMIL NADU.

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Preliminary investigation for placer gold carried out in the Krishnagiri area has indicated significant results. Three types of quaternary sediments were identified in the area viz. 1. Colluvium in the Maharajagadai block over an area of about 0.2 sq.km., 2. Older alluvium along the major streams such as Veppanapalli Nadi, Nachikuppam Ar and Markanda Nadi.

In the colluvial deposits, most of the heaps of colluvium appear to be dumps of old panning activity. Some encouraging values, varying from trace to 0.15 gm/cu.m were obtained in the undisturbed talus along the base of the dumps.

Preliminary investigation by pitting over a stretch of 2 km of the Tadatarai-Dasirapalli section in the older alluvium has indicated economic concentration with gold values ranging from 0.044 to 0.226 gm/cu.m spread over an area of about one sq.km.

Regional traverses were carried out in the newer alluvium along the major streams and river collecting samples at strategic locations representing various geomorphological units for regional appraisal. This indicated incidence of visible gold specks over a cumulative length of about 50 km.

Palaeo-channels are the more promising sources of placer gold concentration. Considering the presence of vast flood-plains in the area, there is a very high scope of locating economically feasible palaeo-placer gold deposits which can be delineated by shallow seismic refraction/reflection and gravity methods.

ECONOMIC MINERALS IN THE BEACH SANDS OF THE SOUTH EASTERN BANGLADESH

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The fine-grained, well-sorted beach sands of southeastern Bangladesh contain about 12% heavy minerals. Among them the economic placers are almandine garnet, ilmenite, magnetite, rutile, zircon and monazite. Ilmenite (both unaltered and altered) is predominant opaque mineral (10-33% of the total heavy). About 50% of the unaltered ilmenite contain ilmenite-hematite exsolution that has been classed to six textural types. The widespread exsolutions offer greater evidence for an igneous source rather than metamorphic. Altered ilmenites (10-15% of the total ilmenites) are seen only in unexsolved part of ilmenite and have the composition of $(Fe^{2+}_{0.77} Fe^{3+}_{0.84}) Ti_{1.93}O_6$ for pseudoilmenite, $(Fe^{2+}_{0.27} Fe^{3+}_{1.07}) Ti_{2.02}O_6$ for pseudorutile and TiO_2 for leucoxene. The exsolution features in ilmenite along with their EPMA data signal to directions of plutonic sources. TiO_2 reserve in this beach sand is found to be 6.14 kg per tonne (1 metric tonne = 1000kg).

Magnetite and titanomagnetite constitute 2 to 7 modal percent of the total heavy minerals. Magnetite are mostly chemically and optically homogeneous and contain less than 2% ulvospinel. Intergrowth of ilmenite with titanomagnetite possibly resulted from oxidation of ulvospinel-magnetite and regular partitioning of Cr, V, Al, Mg and Mn observed between coexisting titanomagnetite and ilmenite suggests a chemical equilibrium. The temperature and oxygen fugacity of co-existing titanomagnetite-ilmenite phases as calculated ranged from 625°-$+850^{\circ}$ and 10^{-13} to 10^{-21} respectively. These temperatures and oxygen fugacity equilibrated in a T-fO_2 field very near to FMQ buffer curve, lending support to its genesis in the upper crust, more being of igneous source rather than metamorphic.

Zircon separates from various localities vary from 2 to 6%. These zircons are mostly colorless and rounded. Zoning and overgrowth are less common. Morphological features and EPMA data suggests that the sources of these Zircons are acid igneous rocks.

OCCURRENCE OF PLACER DEPOSITS ALONG THE COAST BETWEEN VEDARANYAM AND RAMESHWARAM, EAST COAST OF INDIA.

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Along the coast between Vedaranyam and Rameshwaram, east coast of India. sediments from seven stations in the offshore, nine stations in the beach and four stations in the inland environments were collected for the heavy mineral studies. In the offshore samples the heavy mineral variation is present in the range of 0.55 to 79.00%, 3.41 to 71.42% and 1.25 to 56.52%, while in the beach samples in the range of 0.30 to 66.92%, 0.80 to 24% and 1.21 to 76.19% and the inland samples in the range of 0.55 to 27.42%, 0.46 to 8.80% and 0.44 to 33.33% in the 2.5, 3 and 4 phi sizes, respectively. When considering the present as the key to the past, an almost similar depositional processes acting on the present day offshore environment might have happened in the paleo-past in developing the different geomorphological features in those beaches and inland. Two types of factor analyses, i.e. R-mode and Q-mode, were carried out to identify the causes for the variation of heavy minerals in the sediments. The R-mode factor analysis carried out to know the total heavy mineral distribution and its influences on the environment of deposition. It has shown that three factors are influencing the total heavy mineral distribution. The factors are named as 1) the size, 2) sorting and 3) mean grain size in relation to concentration of heavies in overall environments. . Based on the results of Q-mode factor analysis, it may be inferred that almost similar nature of present day processes must have prevailed in the paleopast, too. In the present investigation, the presence of ilmenite, magnetite and garnet rich sands is found to be on the surface for 1 m thickness. However, the exploration is expected to be done for a minimum of 0.1 m thickness as a multimineral deposit. The reserves are estimated on very conservative way by considering as an area of 150 km length, 1 km width (both beach ridges and backshore environments) and the sand thickness of 0.1 m only. The results given here as reserves are categorised as probable.

Based on the above data, the present estimated probable reserves of the ilmenite, magnetite and the garnet in the study area are to the tune of 4.9 MT, 4.3 MT and 6.0 MT, respectively. The representative analysis obtained for the samples from Alagankulam, Janavali, Thiruchitrambalam, Kallimodu, etc. of inland stations, where the Quaternary deposits are found to have been extended. It may be inferred that there might be an existence of buried placer deposits presumed of similar strength. If it should be considered as a block of 20 km width, 150 km length and the probable concentration of 11%, 9.8% and 12.6% for ilmenite, magnetite and garnet, respectively, the probable reserves may go to the extent of as 87.9 MT of magnetite, 98.6 MT of ilmenite and 120.5 MT of Garnet. However, an extensive exploration can be carried out to establish the economically viable exploitation of these placers.

MINERALOGY OF THE KOVALAM BEACH SEDIMENTS OF KERALA COAST, INDIA

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Sediment samples collected from different parts of the Kovalam beach, Kerala have been studied for their mineralogical studies. Results indicate that opaques, zircon, garnet, rutile, tourmaline, monazite and epidote are the principal heavy minerals. On the basis of their realtive abundance and distribution, three mineral association are recognised viz (i) zircon-tourmanline-monazite rich association (ii) Garnet-epidote-zircon rich association and (iii) Opaques-rutile rich association. The heavy mineral assemblages suggest that the provenance having basic and acid igneous rocks, low to medium and high grade metamorphic rocks predominantly granite gneiss

THEME II

EXPLOITATION AND ECONOMIC FEASIBILITY OF PLACERS INCLUDING MODELLING

OFFSHORE PLACERS OF THE SOUTHWEST COAST OF INDIA - EXPLOITATION PROSPECTS

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Placer deposits occur along the beaches and offshore areas of the continental margin of southwest India. The placer heavy minerals of Manavalakurichi and Chavara are mined onshore. Recent surveys show the offshore placers are even higher. A comprehensive study of the Quaternary geological history will be quite promising in establishing the still stands of sea level and corresponding coast lines of the southwest coast of India. Many advances have been made in offshore hydrocarbon exploration and exploitation in our country but the same amount of success could not be achieved in the case of the offshore placers. With the existing experience and marine technology expertise available in the country, there may not be any difficulty in going ahead with the mining activities. An effort is made to bring the problems to be solved in the offshore placers of the southwest coast of India.

SIGNIFICANCE OF RARE EARTH CONTAINING HEAVY MINERALS SANDS IN THE MODERN TIMES

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We receive great benefit from marine resources. Major marine resources include biological, energy, minerals and material resources. We must not only enjoy the benefits of these resources now, but also place responsibility for maintaining these natural resources for posterity. With this mind it is necessary and vital to collect scientific data and information on present sea conditions as well as on biological energy, and mineral resources for their sustainable development.

At present times, environmental issues such as global warming, desertification and so on have become the centre of public debate. These issues will become more important year by year. In fact the twentyfirst century will focus more on these issues. When the consumption of resources increases as a consequence the global environment will be affected. Therefore, worldwide co-operation to secure a comfortable living standard while sustaining the global environment is necessary. For this purpose it may be necessary also to create new socio-economic order for recycling of resources.

This paper focusses on placer deposits of the Indian coast. These deposits are known for their REE elements. Asia has one of the largest reserves of RE ores. It is also a large producer of mined rare earths, and share world's major market for REE's. In 1997 Japan and SE Asia accounted for an estimated 24500 t (37%) of the 66000 t of contain Rare Earth Oxide (REO) consumed world wide. China is at present the largest market holders. India could complete to get a big share, How do we achieve this? It is important to make reassessment of the beach and offshore placer minerals which are a source of REE's especially aiming at reducing the loss of resources at the mining site and beneficiation. This will help conserve the rich deposits of Kerala and elsewhere and give a good yield for several years to come.

AN ALTERNATE METHOD FOR ESTIMATION OF BEACH SAND PLACER RESERVES

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Beach placer deposits of varied size and grade occur at several places along the eastern and western sea boards of India. The principal heavy mineral constituents of these deposits are ilmenite, rutile, zircon, monazite, garnet, sillimanite and magnetite. For the reserve estimation of beach sand minerals, over the years the traditional method of grain counting is adopted by the mineralogist to arrive at weight percentage of individual heavy mineral. The systematic mineralogical analysis by grain counting method is tedious, time consuming, costly and strenous with a multitude of mathematical calculation right from the first step of desliming of beach sand sample to the final stage of calculating the weight percentages of mineral. Separation of heavy minerals present in the placers by organic liquids such as Bromoform ($CHBr_3$), Methelene Iodide (CH_2I_2), etc. involving repetitive stages is not only costly but also hazardous to the mineralogist. Further, it is strainful to the eyes, as the mineralogist has to count at least 900 to 1000 number of grains in each product of sieve analysis. The present technique discussed can directly calculate the weight percentages of mineral from major elemental oxide analysis, with minimum present in the deposit and estimation of their major elemental oxide by standard chemical methods using the stoichometric chemical composition of individual heavy minerals as reference material. The mineral content of unknown is arrived at by the allotment of major elemental oxides on elimination of oxides one after the other based on Norms arrived at by scientific reasoning. The present paper illustrates the methodology adopted in calculation of heavy minerals present in the placers of Srikurmum - Srikakulam district of A.P. as a case study. The study of the above placer sands by this tecnique indicated 38.38% of heavy minerals. The heavy media separation of these sands yielded 37.89% heavy minerals. Thus, both methods of estimation of heavy minerals are almost similar and hence, this method can be adopted as reliable alternative to the conventional mineralogical method.

ECONOMICS OF EXPLOITATION OF GARNET ALONG THE COAST BETWEEN MAHABALIPURAM AND SADRAS, TAMIL NADU.

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To take India on top of the world in regard to economic advancement in the new millennium and to eradicate the paramount problems of poverty and unemployment from Indian soil totally, there has to be a turnaround in the economic activities from land to ocean including the coastal zone.

The Indian coast is richly endowed with placer deposits. However, placer mining is not commensurate with the potential resources. With the primary objective of accentuating the production of placer minerals, a geological exploratory study coupled with economic feasibility study is carried out along the coast between Pondicherry and Chennai.

Based on texture, mineralogy and individual mineral chemistry, the placer deposits are identified and estimated. The heavy mineral deposits of garnet are found around Mahabalipuram and Sadras. In this mineral rich zone, about 23.2% of non-magnetic heavy minerals is estimated to be present. Of this 23.2%, one third is garnet, the mineral currently in great demand, especially for exports.

Using the popular budgeting techniques, namely, net present value, internal rate of return and simple payback period analysis, the economics of garnet mining is analysed in December, 1999 prices. Sensitivity analysis is employed with a view to accommodating the risks associated with beach placer mining. The major factors considered for sensitivity analysis are capital cost, operating cost and annual revenue.

In the base line model, the estimated capital cost is calculated to be 2.5 crores for the plant size of 100 tonnes throughput per day. The annual operating expenditure is 0.5 crores and the annual revenue stands at 0.98

crore. The life of the project is taken as 25 years. The internal rate of return is 15% and the payback period for the base case is computed to be 5.2 years. The sensitivity analysis reveals that the annual revenue is the more influential factor in determining the economic return.

Thus, considering the present market rate of interest the garnet mining in the study area is marginally profitable. In view of the fact that the exploitation of other placer minerals like ilmenite and zircon as byproducts with small additional investment, placer mining in the study area will be more profitable.

MONAZITE IN THE BEACH PLACERS OF VISAKHAPATNAM-BHIMUNIPATNAM COAST, A.P. - A RELOOK

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Occurrence of monazite, derived from the Eastern Ghats Granulite terrane (EGGT), in the beach placers of Visakhapatnam - Bhimunipatnam coast is known since beginning of this century. AMD has estimated 31.59 MT of raw sand having HM of around 19%, consisting of 0.03% of monazite. It has found to be 6-8% of the bulk of the black sand.

NAA analysis of isodynamically separated monazite shows 7.2 % ThO_2, 0.19% U_3O_8, Ce+La 41.11 % resembled monazite of the highly weathered, extensive areal Khondalite (THO_2 6.31%, CE+ La =39.70%) parentage. X-ray analysis and monazite inclusions in garnet further instructed it is not thorium rich cheralite, sourced from limited, massive exposure of charnockite (ThO_2 23.99%, U_3O_8 = 3.08%. Ce+ La 36.56%) as acknowledged earlier. A few grains may contain high content of thorium, since they feed to the beach from varied lithounits, that may not represent true nature of the deposit. Though slight elevated radiation levels were observed compared to the south of this deposit, this may be due to higher concentration of monazite but not due to thorium content.

Unclear potrate of monazite and other associated minerals including parentage, warrants more detailed grain specific elemental chemistry of EGGT as well as from the deposits are needed before come to conclusion. Discovery of fertile thorium deposits to supplement India's Fast breeder third phase nuclear power programme is welcomed.

SUSTAINABLE PLACER MINERAL RESOURCE DEVELOPMENT - AGENDA FOR THE NEXT MILLENNIUM

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Mineral development and conservation has been a crucial agenda for the economic development in the developing countries. Especially in India, it has attained a special frontline status in the economic growth and technological progress. Beside, other strategic minerals like placers would occupy a pinnacle importance in the next millennium. As the reserves of various heavy minerals indicate comfortable status for mining and utilization. In this juncture, it is imperative to elaborate the conservation and sustainable management strategies for placer resource development.

Placer mineral resource development encompasses five major components, viz., **exploration** including reserve estimation, **mining** including reclamation, **mineral processing** including value-addition, **environmental management** including impact assessment and **economic viability** including marketing strategies. The existing scenario in all the spheres of placer development has been evaluated and the substantial gaps and significant lacunae in sustainable development highlighted.

Though the exploration works are reported widely in east and west coasts in India, exploitation aspect is narrowly confined to limited parts of south India. Mushrooming garnet mining activities are observed along Tuticorin coast. Mining activity needs to be coupled with holistic environmental studies to understand and minimise the anticipated impacts on fragile coastal environment. A road map for this aspect has been enumerated in this paper. The importance of beach mineral processing, a vital aspect of mineral conservation, is comprehensively discussed and strategies are outlined. Some attitudes related to socio-economic dimension are reviewed.

Based on the supportive capacity of the placer deposits and techno-economic constrains of mineral development, action plan with targeted objectives and time-frame of achievement in each of the sub-system of resources development has been formulated. The case for an integrated action plan to successfully harness the bounty from the ocean, especially placer deposits, is presented as the agenda for the next millennium.

THEME III

ENVIRONMENTAL IMPACT OF PLACER EXPLORATION AND EXPLOITATION

QUATERNARY PLACER DEPOSITS OF PANNA DIAMOND BELT, M.P.

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Quaternary diamondiferous placers of Panna Diamond Belt occur in two distinct modes. The first mode of occurrence is in the form of veneer of lateritic gravel covering Baghain Sandstone Surface and Gahadra Sandstone Surface. The second mode of occurrence is in the form of alluvial gravel along the streams draining Panna Diamond Belt.

The lateritic gravel over both the surfaces is the product of lateritisation of sandstones and occurs in the form of veneer, the thickness of which ranges from less than 1 meter to about 3 meters. Prominent diamondiferous workings on Baghain Sandstone surface are Arshiani, Mahuatola, Chanda, Bardhai, Baram Ki Kuiya, Majha, Kurari, Ranipur, Shahidan, Harra Chowki and Bangla-Rohania Mines. The best known blocks on Gahadra Sandstone surface are Sakaria, Udesna, Thuhai, Laliki, Jhiriyan, Brindavan and Mahatain workings. Locally, these mines are called as "Chilla" mines and are actively worked by local private mines.

The lateritic gravel occurs as sheets and also along the joints and fractures of the host sandstone. The gravel comprises dominant lateritic gravel with fragments of sandstone, vein quartz and jasper. The diamonds in the gravel are derived from Neoproterozoic-Palaeozoic diamondiferous conglomerates associated with Rewa Group of rocks of Vindhyan Supergroup. The incidence of diamonds is very low and in most of the cases, they are chance findings.

Quaternary diamondiferous alluvial gravel is recorded along most of the streams draining Panna diamond belt. The alluvial gravel along Baghain river is rich in diamonds and, till a few years back was mined by National Mineral Development Corporation in the vicinity of village Ramkheria. Exploration in Ramkheria area by NMDC with the help of 260 drill holes and 300 pits indicated 1,15,000 carats of diamonds with incidence of about

16 carats/100 tonnes. During 1955-56 GSI explored part of the Baghain river gravel in Ramkheria area and established incidence of 26 carats/100 tonnes. Geophysical surveys by Geological Survey of India established three dimensional geometry of the Baghain river gravel.

Baghain river drains Baghain sandstone of Kaimpur Group alongwith the diamondiferous conglomerate which occurs at the contact of Kaimpur and Rewa Group of rocks. The depth of gravel mines varies from 5 m to about 17 m. In a typical section about 1 to 4 meters thick diamondiferous is overlain by about 10-12 m thick silt. The gravel comprises pebbles of sandstone and granules of vein quartz, jasper and chert. Chehala nala gravels on Baghain sandstone surface is another prominent gravel horizon which is being actively mined. The major contribution of diamonds for this gravel is from diamondiferous Jhiri conglomerate and Itwa conglomerate which occur abundantly in the provenance.

Diamondiferous alluvial gravel is also recorded along streams draining Vindhyan Supergroup of rocks and basement granites. The prominent gravel horizons along down stream of Baghain river near Kohari, along Chehala east of Kohari, Ranj river, Dalsagar nala, Chhapar nala and Mohar nadi are also important sources of diamonds.

Most of the lateritic and alluvial gravel workings are actively mined by unorganised private sector who take yearly lease from State Government of M.P. As compared to the diamonds recovered from Majhgawan Kimberlite, the diamonds recovered from gravel are of precious to semi-precious variety and retain their crystal geometry. Diamonds as large as 40 carats have been recovered from these gravels.

PLACERS DEPOSITS OF ILMENITE SAND ALONG THE COAST SOUTHWEST OF VEMBAR TO VAIPPAR RIVER MOUTH, TIRUNELVELI DISTRICT, TAMIL NADU

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Beach placers with concentration of ilmenite (over 50% by visual estimate) were located along the sea shore above the high water line (tide) commencing from 2 km west of Vembar and continue upto Vaippar river mouth. The sandy shores of backwaters are the repository of ilmenite placers; besides this river sands are also highly enriched in ilmenite and 12 to 25m in width increases to more than 75m with thickness over 1m.

A total of seven samples analysed on an average, contain 32% TiO_2 and 28% Fe_2O_3. The electro-magnetic separation of 10 samples by iso-dynamic separator indicated the presence of magnetic, feebly magnetic and paramagnetic minerals, like magnetite, ilmenite, garnet, zircon and rutile. G.M. counter detected a background value of 20 indicating the probable presence of monazite in the beach sands. Heavy minerals of Manavalakurichi and Chavara are mined on shore. Recent surveys show the offshore placers are even higher. A comprehensive study of the Quaternary geological history will be quite promising in establishing the still stands of sea level and corresponding coast lines of the southwest coast of India. Many advances have been made in offshore hydrocarbon exploration and exploitation in our country but the same amount of success could not be achieved in case the of offshore placers. With the existing experience and marine technology expertise available in the country, there may not be any difficulty in going ahead with the mining activities. An effort is made to bring the problems to be solved in the offshore placers of the southwest coast of India.

PLACER ENRICHED TIDAL SECTORS OF STREAMS AROUND PURANGAD CREEK, MAHARASHTRA, INDIA

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There is a wide range of sedimentary environments on the coast of Maharashtra, India, where heavy mineral deposits are found. Streams draining into creeks and estuaries are the prime areas enriched by placer deposits. The construction of bridges across the rivers, in recent years as a part of coastal highway, has opened up new areas which are essentially very remote and the extent and quantum of placer minerals are not concentrated in pockets but lie scattered along this coast in the form of medium to small size deposits, especially in the estuaries, creeks, sub creeks and tidal channels.

This paper tries to study the area around a creek where large quantities of placers are found. The construction of coastal highway bridge on river Muchkundi at Purnagad [16°45'N lat] was complete in 1998/99 and the approach roads connecting the bridge have disturbed the ecology of nearby terraces and also changed gradient of streams draining the creek. The streams joining the tidal mouth of Purnagad creek from south are filled with fine to very fine sand consisting of ilmenite and magnetite. The results of the analysis show that the concentration of ilmenite ranges between 7 and 80% and that of magnetite 2 and 17% only.

The creek is bounded by headlands from north and south. The streams originating on the lateritic hills and plateaus transport the sediments to the foothill sections. The tidal sectors of the streams have a gradient which is as low as one degree and hence, these sectors are conducive for the deposition of sediments. The extent of the deposits is controlled and delimited by nearness to coastal plateaus and the gradient of the stream bed. These sand deposits are enriched by placer minerals. The average thickness of the sands enriched by ilmenite/magnetite is not more than 7 cm along the channel length of 800 m. The channels are on average 20 m wide. The study suggests that the exploration of small, swift, shallow streams joining the creek is now possible due to easy accessibility and together all such streams can provide a sizeable amount of heavy minerals of economic importance.

THEME IV

DATING OF PLACER DEPOSITS

ENVIRONMENTAL GEOMORPHOLOGY OF BEACH PLACERS OF SOUTHERN TAMIL NADU COAST

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Environmental Geomorphology implies upon the inter-relationship between anthropogenic action on geomorphic products and its resultant impact on environmental components. Beach placers, which are necessarily of geomorphic products formed under an unique geomorphic environment, has a sensitive linkage with fragile coastal environment in respect to its formation and localities. If any attempt has been made to dislocate or deform the geomorphology of placer deposits by means of mining, one can expect a severe environmental impact on the associated coastal environment.

Coastal geomorphological assessment and evaluation on heavy minerals based on detailed auger survey have indicated that the beach placers of southern Tamil Nadu has been controlled by geomorphology and Quaternary neo-tectonics. These placer deposits have been nurtured by the coastal processes in the suitable geomorphologically controlled locations. These geomorphological traps that have been resulted due to strike-slip-hinge-fault system cause the placers to accumulate into significant placer centers. It has been emphasized in this paper that the placer deposits in the study area are the resultant response of unique combination of geomorphic processes at given fragile environmental situations. Exploitation of such placers must have been planned systematically with an appropriate environmental impact evaluation.

In addition to present day beach placers, palaeo-placer deposits have been demarcated as deduced from integrated Quaternary sea-level studies. These deposits that have been found along ancient shorelines indicate striking palaeo-environment scenario and ancient geomorphological processes. As far as the mining of placers are concerned in the study area, one cannot overrule the geomorphological degradation and associated environmental risks. Eco-friendly mining practices are warranted to dismiss the probable environmental hazards in coastal environment. Present status of environmental impact due to on-going coastal mining is addressed in this paper and suggestions leading to management plan has been enumerated.

HEAVY MINERALS AND COASTAL VEGETATION DURING LATE HOLOCENE IN PICHAVARAM, TAMIL NADU, INDIA

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The north-eastern part of the Cauvery Delta formed by Vellar and Coleroon river constitutes a part of the eastern continental margin in the Bay of Bengal. Both the rivers traverse through major geological units viz: (i) Granite gneiss, (ii) Charnokites of Precambrian age and (iii) Cuddalore sandstone of Miocene- Pliocene age.

A 2 m semi-solid sedimentary profile in the vicinity of mangrove forest of Pichavaram, Tamil Nadu that was deposited during the time period of late Holocene (approx. 3500 yrs. BP to present) was studied. The quantitative and qualitative analysis of the samples at 10 cm interval each shows great variability. Based on the present study it could be divided into four phases viz: I,II,III and IV. The highest deposition of the Total Heavy Mineral (THM) concentration was during 1170 yrs BP to present(Phase IV) that gradually decreased showing fluctuating trend with abrupt absence of THM at 90 - 100 cm depth. The beginning of late Holocene shows minimum grain concentration but the grain size is increased. It is evident that the grain characteristics differ through time, perhaps influenced by either high water regime during transportation or lithological changes in the provenance.

The chronostratigraphical vegetational reconstruction using the palynological data along the coast (since late Holocene) was also studied. Four consequent cycles of palaeoecological changes that might have affected the coastal vegetation wet and humid climatic conditions with favourable sea water influence. However, phase II and IV indicate dry climatic condition with perhaps, a fall in the sea level. The THM assemblage shows close variability with the coastal wetland vegetation. Hence, besides many other advantages, the coastal wetland vegetation also plays a beneficial role in heavy mineral deposition in an estuary.

THEME V

MINING AND PROCESSING TECHNOLOGY OF PLACERS

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STUDIES ON GRINDING OF ZIRCON AND SILLIMANITE MINERAL SAMPLES FROM INDIAN BEACH SANDS

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The industrial minerals like zircon ($ZrSiO_4$) and sillimanite (Al_2OSiO_4) are extensively used in the manufacture of refractory bricks and in other related applications. India is endowed with adequate resources of these minerals in the coastal beach sands of southern peninsula. However, the minerals find wider applications when ground to finer sizes in the range of <45 μm. Grinding is always an energy intensive and hence cost intensive process. Any attempt to reduce the cost of grinding is a welcome measure especially to the small scale producers of these two minerals.

Detailed laboratory studies were carried out after grinding of zircon and sillimanite mineral concentrates obtained from Indian beach sands. The studies included determination of work index, batch communication kinetics, effect of grinding media, etc. The work index determined using the Bond's work index ball mill at a circulating load of 250% was found to be 28.4 kwh/M.ton and 35.5 kwh/M.ton respectively for zircon and sillimanite. It needs to be mentioned that the scratch hardness (Mohs scale) of these two minerals are 7.5 and 6.5, respectively implying that the hardness and friability are two distinct attributes of the minerals. Based on batch communication kinetic data, the selection (or) rate parameters of Rossin-Rammler equation were estimated for different size fractions retained. The communication model presupposes perfect mixing conditions within the mill and the mill product is assumed to have the same composition as the mill contents. Mathematical models have been developed for median size of the ground product using the kinetic data obtained by two different grinding media namely steel balls of density 7800 kg/m^3 and alumina balls of density 3900 kg/m^3. The studies carried out were aimed at estimating the specific power requirements and other grinding conditions to get the optimum mill product.

MINING AND PROCESSING OF INDIAN GOLD PLACERS - A VIEW

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There are known placer gold deposits in India reported from Karnataka, Kerala, Tamil Nadu, Andhra Pradesh, Orissa, Bihar and Uttar Pradesh. The placers are worked for recovery of gold by selective mining and gravity concentration. There are modern methods of treating placers by gravity concentration using Spiral and Knellson concentrators. The gravity concentrate may be further treated by all pulp cyanidation and by carbon-in-pulp. This depends upon the quality and quantity of concentrate. The gravity concentrate could be directly smelted to produce gold bullion. A flow sheet is suggested for treatment of Indian gold placer deposits economically.

THE USE OF ROCK MAGNETIC TECHNIQUES IN PLACER EXPLORATION

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Rock magnetic properties like magnetic susceptibility, anhysteretic remnant magnetization and isothermal remnant magnetization at different field strengths have been measured for beach and offshore placer samples from the southwest coast of India. It is found that these properties exhibit strong correlations with heavy mineral and opaque mineral contents ($r>0.87$ and $r>0.94$, respectively, both significant at the 1% level). As placers contain one or more types of magnetic minerals, it is suggested that magnetic properties may be used as a "proxy" for heavy mineral and opaque mineral contents. Because they are simple, rapid, inexpensive and non-destructive, magnetic methods may be employed by those engaged in placer exploration. One can quickly scan a large number of samples and demarcate potential areas for further investigations. It may be pointed out that conventional methods to obtain heavy and opaque mineral data tedious work of counting a large number of grains under the microscope. Therefore, the proposed rock magnetic methodology saves considerable time and tedium. An important lacuna in this methodology is that the ratio of magnetic mineral to heavy or opaque mineral contents should not vary significantly.

GARNET COLLECTION IN THE COASTAL AREA - AN ECO-FRIENDLY MINING

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Garnet is one of the beach minerals found in the coastal area. The coastal stretch consists of recent alluvium and beach sands, noticed in the landforms of beaches, beach terraces, dunes and teri soils. The relief ranges from 1.5 to 6 m. The garnet available in two zones namely Zone A - Littoral zone and Zone B - Non tidal zone and in the thickness of 5 to 30 cm from the surface. The garnet mining in the leasehold areas such as Nambiyar river mouth, etc., is being carried out to 15 m wide stretch of littoral zone. It is done manually using shovels, spades and baskets without involving any benches, slopes or angles upto a depth of 5 to 20 cm. Actually, it should not be called as mining instead it should be called as collection of garnet only.

However, detailed study was conducted on environmental impact of the garnet mining. The following aspects such as sea water - ground water interface, salinity, effect on buildings, shoreline changes, coastal erosion, fishing activity, fauna and flora, and, air and water pollution were studied and its impact are assessed. The study reveals that there is no significant impact on environment because of the mining of the garnets.

Further, the eco-friendly garnet mining may provide a good number of employment as well as revenue primarily in the form of foreign exchange. In this circumstance, the government state as well as central should provide all encouragement and support for the mining activities of garnet.

THEME VI

ROLE OF GEOSCIENTIFIC PHENOMENON IN THE DISTRIBUTION AND ENRICHMENT OF PLACERS, PROVENANCE, ETC.

MINERALOGY AND CHEMISTRY OF ILMENITES FROM THE BEACH PLACERS OF MANDAPAM TO KANYAKUMARI REGION, TAMIL NADU

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Ilmenites from the beach placers of Mandapam - Kanyakumari show five types of intergrowth patterns viz., ilmenite-hematite, magnetite-ilmenite, ilmenite-hematite-rutile, hematite-ilmenite-rutile and ilmenite-rutile in all samples. At Kuttankuli and Kuduthalai areas, ilmenites are predominantly of an unexsolved nature, whereas at Kallar, Vaipar and Valinokkam stations they are more of an exsolved nature with a wide spectrum of textural is more abundant. These exsolved and unexsolved phases of ilmenite from different locations were confirmed by x-ray diffraction analysis. Major element variations of ilmenites show a close correlation with the nature of the intergrowth pattern. REE patterns of ilmenites show a strong negative Eu- and Ce- anomalies, indicating the prevalence of redox conditions at the time of crystalisation. On the basis of modal analysis, viz. width of intergrowth lamellae of the ilmenite-hematite phase and unexsolved ilmenite percentage, and major, trace and rare earth element composition, these ilmenites are inferred to have been derived from metamorphic rather than igneous sources, with prevalence of a common source to the entire study region.

MINERALOGY AND GEOCHEMISTRY OF OPAQUE MINERALS FROM THE BEACH SANDS OF CENTRAL TAMIL NADU COAST

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Black sands occur in layer and patches along the central Tamil Nadu coast have been investigated. Detailed microscopic studies of beach samples were examined. The opaque minerals are particularly rich in ilmenite with small quantities of magnetite. Ilmenite is characterised by the presence of ilmenite with small quantities of magnetite. Ilmenite is characterised by the presence of ilmenite with hematite, ilmenite with leucoxene, magnetite, magnetite and hematite, whereas magnetite is with ilmenite, magnetite with hematite, magnetite with ilmenite, hematite and martite as exsolution. Based on grain size studies, the study area has been divided three sectors namely south, centre and north. Ilmenites of the southeast sector is mostly exsolved ilmenite and is concentrated in the coarser fractions. In the northern sector, it is in the finer fractions whereas magnetites are found in coarser fractions of the respective sectors.

The intergrowth lamellae of hematite in ilmenite is taken to differentiate the igneous and metamorphic source in the respective sectors. The elemental composition of detrital ilmenite grain is found to be useful as provenance indicators for the beach sediments of the different sectors of the area.

Most of the magnetites are found to have exsolved hematite and ilmenite. The lamellae are noticed to be very fine in nature and attributes the igneous source. The elemental analysis of magnetite shows that a distinct difference in geochemistry between northern sectors and the other two sectors. However, in general, a comparison of percentage of elements in ilmenite and magnetite are not consistent and are much distinct. The paper clearly signifies that the study of mineralogy and geochemistry of opaques can be used as a reliable guide to as certain the specific types of source rocks.

MINERALOGICAL - TEXTURAL - CHEMICAL VARIATION IN HEAVY MINERAL BEACH SAND DEPOSITS OF ANDHRA PRADESH STATE, EAST COAST, INDIA

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The State of Andhra Pradesh along the East coast of India has a coastal length of about 960 km with a width varying from about 60 m to as much as 3 km, comprising both beach and well developed dunal systems. Detailed investigations with close space drilling and sampling of the sand body upto the bed rock have resulted in the estimation of huge reserves of heavy minerals in general and ilmenite in particular. Based on the major drainage system, hinterland geology, marked variations are observed in texture, mineralogy and chemical characterisation. Andhra Pradesh coast has been divided into three sectors:

1. Northern sector between Donkuru and Pentakota has a youthful river system comprising Vamsadhara, Nagavalli, Champavathi, Gosthani, Sarada, Varaha and Tandava rivers draining through the Eastern ghat mobile belt comprising of khondalites, charnockites, leptynites and granites. Hence typical heavy mineral assemblage of ilmenite is found to containe 50 to 53% TiO_2 with negligible amounts of vanadium and chromium. The grade of the minerals is of ilmenite (6-14%), garnet (5-9%), sillimanite (3-6%), rutile (0.4 -0.8%), leucoxene (0.3-0.6%), zircon (0.2-0.5%) and monazite (0.05-0.17%). The commercially exploitable deposits in this sector are at Bhavanapadu, Kalingapatnam, Koyyam, Bhimiunipatnam and Pentakota.

2. The Central sector from Pentakota to Suryalanka has a mature drainage system represented by two major rivers Godavari and Krishna. These rivers have their origin in Deccan traps and they drain through Pecambrian granites/gneisses and the eastern ghats. Godavari river also drains through the Gondwana and Tertiary sediments. As a result of these, a distinct mineral

assemblage of pyriboles-ilmenite- magnetite with very fine to medium grain size is observed. The TiO_2 content of pure ilmenite is 48% with negligible amounts of chromium and vanadium. The grade of the different minerals is of pyriboles (2.53%), rutile (0.13%), leucoxene (0.06%) and monazite (0.05%). The major deposits in this sector is at Kakinada.

3. The southern sector between Suryalanka and Ramayapatnam has rivers like Pennar, Upputeru and Swarnamukhi which are neither matured nor youthful and are in between the two sages. These rivers drain the Cuddapah and Kurnool metasediments, the gneisses of Dharwar group and the low grade Nellore schist belt. The mineral assemblage of ilmenite- magnetite-pyroboles with coarser grains is distinctly observed. The TiO_2 content is around 48%. The grade of different minerals is of pyriboles (1-8%), ilmenite (0.97-3.0%), rutile (0.04-0.25%) zircon (0.04-0.24%), magnetite (0.02-0.03%), leucoxene (0.02%) and monazite (>0.05%).

Thus, the controls on the concentration of heavy minerals have a geological time range from early Quaternary to late Holocene. Integrated studies comprising digital and visual interpretation of satellite data coupled with ground mapping of fluvio-marine geomorphic landforms, similarity in sedimentological parameters like skewness, kurtosis, etc in beach, frontal, inter and rear dunes and also at different depth level all indicated the presence of paleo strand lines and thereby the role played by late Quaternary sea level fluctuations. The growth in global demand for many of the above placer heavy minerals, the huge reserves with good grade, suitable mineral chemistry, availability of good industrial infrastructure collectively warrant exploitation and extraction of these valuable minerals.

PALEOTOPOGRAPHY AND ITS INFLUENCE ON THE NEARSHORE PLACER ACCUMULATIONS, OFF KONKAN, CENTRAL WEST COAST OF INDIA

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The high resolution shallow seismic and magnetic profiling along with detailed bathymetry and geological sampling along the Konkan coast (Lat 17°20' to 16°30' N, Long 73°05' 73°15' E) to understand the sedimentation pattern, the lateral continuity of rich beach placers in the offshore, their vertical thickness, the nature and structure of the basement to understand the structural evolution of nearshore zone, indicated that the beach placers extend offshore to a water depth of 10-12 m beyond which they are covered by clays. The seismic profiles show well recognised five stratal surfaces viz., clay, sand, sand and pebble, altered trap and trap (acoustic basement). The acoustic basement is highly undulatory and is encountered at a depth of 10 m below seabed which deepens to more than 50 m offshore with a westerly dip.. The highly undulatory nature of acoustic basement suggests prolonged erosion before sedimentation due to transgression in early Holocene.

The basement configuration displays steplike features from north-south, which might have developed due to block uplifting and controlled by E-W faults/ lineaments. Besides, the continued erosion of river channel in time has contributed to the development of valley like depressions in the basement. The presence of such features off Jaigad, Ratnagiri, Purangad, Rajapur and Vijaydurg bays are attributed to the paleocourses of rivers such as Shastri, Kajvi, Machkandi, Kodavil and Vaghotan, respectively. Such paleo channels are also noted in Varvade, Kalbadevi, Pawas and Wada Vetye bays where hinterland is indented by minor streams. These paleoriver/ paleostream channels are the sources of appreciable concentrations of heavy minerals in the form of sands.

Analysis of the magnetic data depicts the offshore extension of coastal lineaments in the NNW-SSE, and N-S direction. These lineaments serve as traps for placers and are proved to be older than Deccan trap.

The seismic and magnetic data also show large number of minor faults which are found to be affecting not only the basement but also overlying sediments and probably corresponds to neotectonic activity.

These structural features appear to have influenced the development of depositional basin and in turn, the sedimentation process and heavy mineral distribution patterns in the nearshore zone.

SOME ASPECTS OF GEOCHEMICAL CHARACTERISTICS OF ILMENITE PLACER DEPOSITS OF TAMILNADU, INDIA.

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The chemical analyses of ilmenite separate from beach placer deposits of Tamilnadu indicate that it is a distinct species of crichtonite with more enrichment of Ti, Fe^3 and e^3 than ilmenite. The triangular plot of these concomittant depletion of Fe^3.. e^3 in octahedral co-ordination on the basis of 6 (O) anions is very much lower than 2 but it is almost around 1 in most of the ilmenite. The significant enrichment of Fe^3 in tetrahedral lattice indicates a deviation from ilmenite structure to crichtonite. However, an addition of Fe^3in the octahedral coordination nearly balances ilmenite structure and variation between tetrahedral co-ordinate and octahedral co-ordinated ions show very limited extent and this feature indicates that, the original ilmenite is enriched with significant ferrous iron prior to oxidation. The progressive linear variation accommodating higher content of Zr vs Si or Al; Ti Vs Fe3 or Al and Cr vs Fe3 in ilmenite indicates that ilmenite enriches these constituents progressively due to superheating of subsoildus ilmenite which in turn formed by crystallisation and differentiation from a superheating/ ascending/degassing basaltic magma. The existence of negative correlation between V vs P; Mn vs Mg; Ti vs octahedral ions or Mg or Fe leads to enrichment of V, Mn and Ti during progressive differentiation. Presence of two distinct parallel trends of variation of P vs V; Mg vs Mn; Ti vs octahedral ions or degree of oxidation or Mg ions indicates two generation of ilmenite; one during progressive stages of oxidation and other during progressive differentiation by enrichment of Ti in the ilmenite lattice. The geochemical variation of ilmenite reveals that original ilmenite has crystallized from high temperature basaltic magma. The ilmenite has been significantly oxidised during ascending of the superheated basaltic magma. The significant enrichment of these constituents in ilmenite lattice throws light on its economic potentiality. The significant enrichment of REE, Nb and radioactive elements in ilmenite and the association of monazite, zircon, rutile and

carbonatite lava exposures from various parts of Tamil Nadu and occurrence of phosphates enclosed with carbonate matrix in offshore regions of Chennai indicate extensive very Late Cenozoic/Quaternary carbonatitic lava fissure eruptions in onshore and offshore lands of Tamilnadu.

HEAVY MINERALS FROM THE PENNAR DELTA, EAST COAST OF INDIA

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Heavy mineral assemblages were studied in Pennar Delta from different environments like river channel, natural levee, red sediments, beach ridges, beach lagoon and lagoon island. The heavy minerals identified from different geomorphic landforms are zircon, epidotes, amphiboles and opaques (magnetite and ilmenite). The relative concentrations of different heavy minerals vary in different landforms.

The geological formations in the Pennar watershed basin are mainly Archaean gneisses, Kolar and Sargur type of granite and greenstones, closepet granite, dolerites and Cuddappah and Kurnool sediments.

Zircons are the predominant heavy minerals in the pennar Delta sediments and epidotes, tourmaline and rutile are next in abundance. Different types of zircons identified in the present study are colorless, zoned and authigenic. The colorless zircons, hornblende and epidotes are derived from peninsular gneisses. Provenance study of Pennar drainage basin indicate that the peninsular gneisses and closepet granite equivalents are the dominant lithological units in the upper reaches of the watershed basin. The reported zircon morphology from the closepet granites match with the pink euhedral zircons identified from the present study. The authigenic zircons identified in the Pennar Delta are considered to have been derived from the Cuddappah basin, which was subjected to periodic uplifts.

The heavy minerals processed in the beach and dune environment of Pennar Delta region have occasionally resulted into Placer deposits.

UNIQUE GEOMORPHOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF BEACH PLACER OCCURRENCES IN INDIA - A POSER TO THE EARTH SCIENTISTS

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The major beach placer deposits in India are confined only to the south western and south eastern fringe of the Peninsula, especially, on either side of the Kanyakumari coast. What particular combination of factors would have been responsible or would have led to this unique occurrence, is to be answered by the Geoscientists. Whether it is due to the convex rounded configuration of the landscape or whether it is due to the nearness of the source rock, provenance, whether; it is due to fluvial and marine action; whether it is due to the wave energy; whether it is due to the prevailing wind; whether it is due to the longshore currents; whether it is due to the peculiar weathering and erosional processes; whether it is due to the origin and evolution of the coast; whether it is due to neotectonic activity and finally, whether it is due to dumping of the heavy minerals from the Eastern and Western Ghats (Bay of Bengal and Arabian Sea in the Indian Ocean). The trijunction is unique. What was the depositional setting and concentration mechanism that was congenial between Lat.8° - 10° and Long. 76° -78°. This calls for a mind boggling and brain stroming session.

BEACH PLACER STUDIES DUE TO LITTORAL DRIFT AT KANYAKUMARI COAST

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Beaches provide a glimpse of the nature of the huge offshore reservoir of placer sands. On the beaches of Kanyakumari coast, especially at Manavalakurichi to Midalam and from Lipuram to Vattakottai, placer formation is an active process and at places high concentration of opaque minerals such as ilmenite, magnetite, monazite and garnet produce black sand beaches.

Littoral drift for Kanyakumari coast was developed using the sediment budget approach. An attempt has been made on the application of budget of littoral sediments and the same has proved to be extremely useful in evaluating the importance of heavy mineral sources and losses to nearshore zone and also accounting for regions of erosion and deposition. The study area has been divided into 13 cells, starting from Midalam as cell 1 and Idindakarai as cell 13. The potential amount of sediment movement is an upper limit defined by wave, current and wind parameters.

This littoral drift has led to development of black sand deposits on the south sides of prominent headlands and enrich beach placers at Midalam, Manavalakurichi and at Kovalam beaches in the western part of study area, whereas in the eastern part of the study area, beach placers are enriched in the northern part of Cape Comorin and Chinnamuttam which has been attributed to asymmetry of wave energies reaching this coastal line.

The net littoral drift is 10 million cubic meters per year and the direction is towards south in the north west of Cape Comorin and towards north in the north east of Cape Comorin.

PROVENANCE SIGNATURE OF PRECAMBRIAN AND MESOZOIC ROCKS IN THE NEARSHORE PLACERS OFF KONKAN, CENTRAL WEST COAST OF INDIA

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The offshore geological exploration for heavy mineral placers from the nearshore zone between 3 to 20 m of water depth, covering four bays viz. Wada Vetye, Ambolgarh, Rajapur and Vijaydurg along the Konkan coast west coast of India, indicated that the heavy mineral concentrations in the surficial sands of these bays ranges between 5 to 80%, and their distribution patterns varies from bay to bay. The heavy mineral suite is comprised of both opaques and transparent heavy minerals in variable proportions. The opaques are represented by ilmenite, magnetite and their weathered derivatives like goethite, hematite, martite, etc. The opaques in the hinterland basaltic formations are predominantly composed of highly angular laths of titano-magnetite and minor proportions of granular ilmenite whereas the detrital opaques are rich in rounded magnetite. Surficial texture of detrital ilmenite and magnetite shows the effects of grinding, chemical, etching and impacts suggesting their prolonged transporation and long residence time in depositional basin. The rare earth composition of detrital ilmenite and magnetite shows negative Europium anomaly which is absent in ilmenite and magnetite of hinter land basalt.

The transparent minerals are represented by kyanite, garnet, olivine, augite, rutile, diopside, tremolite, zircon, tourmaline, topaz, hornblende, hypersthene, chlorite, epidote etc. The physical characters like colour, grain morphology, rounding of some of the minerals, ZTR (Zircon, tourmaline and rutile) index indicates their prolonged transporation or recyled nature undergoing repeated reworking and possibility of mixing-up of sediments from different environments, which might have occurred during different transgressional and regressional phases

The Q-mode factor analysis of these transparent minerals clearly indicates the predominant contribution of these minerals from four types of rocks viz, highgrade metamorphics, quartzite, Kaladgi sand stone and Dharwararian sediments, Deccantrap basalt and their weathered derivatives in the assemblages of heavy mineral placers of this area.

SIGNIFICANCE OF HEAVY MINERAL GEOCHEMISTRY IN UNDERSTANDING ENERGY CONDITION AND SEDIMENT TRANSPORT - A CASE STUDY AT ARGE BEACH, WEST COAST OF INDIA

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The study of the geochemical behaviour of certain trace elements in the coastal environment has gained momentum for the last few decades due to its application in understanding provenance, process and depositional environment. However, the geochemical studies of heavy minerals of beach sands are hitherto not reported particularly along central West coast of India. The present study constitutes the heavy mineral geochemistry for selected major and trace elements along Arge Beach near Karwar. An attempt is made in this study to understand the distribution of heavy/light minerals, major and trace elements of the heavy minerals along with sediment texture, confining to the upper and lower beach foreshore.

The elemental distribution suggests that, the concentration of the elements is higher at the lower foreshore compared to upper foreshore. The R - mode factor score plot suggests that the direction of source for major and trace elements that is for heavy minerals / sediments is mainly from northern side of the beach. The study provides some interesting observations which are helpful to understand the prevailing energy conditions and sediment transport using selected major and trace elemental geochemistry of heavy minerals.

RARE EARTH ELEMENT GEOCHEMISTRY OF RIVER-OCEANIC SEDIMENTS FROM THE SOUTH-WESTERN COAST OF INDIA

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Rare earth elements are relatively resistant in sedimentary geological processes than many of metallic elements. Therefore, they concentrate as placer minerals. The western part of India is under the influence of tropical climate. The fresh rocks have been weathered chemically to form deep weathered zones constituted by laterites, lateritic and red soils. Keeping in view of extreme chemical weathering process, this study has been undertaken to distinguish:

(1) the abundance and distribution patterns of rare earth elements (REEs) in river sediments that derived from different fresh rocks,

(2) their distribution during estuarine mixing, and

(3) their behaviour in contrasting geochemical sedimentary environments along the continental shelf-pelagic zone transects.

River sediments derived principally from gneissic terrain have higher Σ REEs (~300 ppm), positive Eu/Eu* and Ce/Ce* anomalies as compared to those from gneisses with upstream greywackes, and charnockites. This suggests that the monotonous tropical climate prevailing in the study area. In both suspended particulate matter (SPM) and bottom sediments, the light REEs (LREEs) fractionate over heavy REEs (HREEs). This is consistent with the trend observed for world major rivers.

From riverine to estuarine environment, Σ REEs in SPM tends to be decreased by factors of 1.3 to 1.8, but, Eu/Eu* and Ce/Ce* anomalies remain unchanged suggesting the deposition of sediments in the estuaries. Furthermore, Σ REEs, Ce/Ce* and to a certain extent Eu/Eu* anomaly tend to decrease from the continental shelf, slope to the pelagic zone, suggesting

a decrease of terrigenous input rather than severe fractionation of REEs in the marine environments. On the contrary, in the marine sediments the component CaCo3 increases away from the shelf to the pelagic zone and thereby, diluting REE concentrations in sediments.

ROLE OF COASTAL GEOMORPHOLOGY AND PROCESSES IN THE ENRICHMENT OF PLACER AROUND KANYAKUMARI

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Geomorphological features and morphodynamic states of beaches along the coastline of Kanyakumari play a vital role in the distribution, control and enrichment of placer. Study of textural characteristics of beach sands and their response to natural barriers is essential to evaluate the coastal dynamic phenomenon. Coastal features like headlands, beach cusps, scarps, sand dunes and limestone cliffs have a bearing on placer distribution and the mineral deposits are concentrated along these depositional controls with gently sloping plains and low to moderate tidal range.

Quantitative assessment of beach changes and demarcation of erosion and accretionary regimes are essential for a proper understanding of placer mechanism and hence, this study has been carried out around Kanyakumari. Evaluation and distribution of longshore sediment along the coastline have also been studied.

Beach deposits have been derived from the adjacent hinterland mainly from garnet biotite gneisses. Important heavy minerals observed are hematite, rutile, monazite, garnet and magnetite. Sorting and liberation of light minerals as sediment transport during the coastal processes are due to the entrainment and settling equivalence. The process and response variables have been recorded using surf scale parameter and various beach states have been established.

Enrichment of placer as minable deposits is attributed to the density contrast between quartz and heavy minerals, coastal hydrodynamics and the resultant 'reworking' and concentration of sediments. Of course, the rocks of the provenance and the morphodynamic features have also contributed for the accumulation of recent sediments. Beaches of Midalam, Manakudi, Kanyakumari, Chinnamuttom and Idindakarai have been identified as reflective type and other beaches as intermediate ones.

A GEOCHEMICAL EVALUATION ON THE HETEROGENEITY OF ILMENITE SANDS FROM SOUTH KERALA

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Ilmenite, the most important placer-forming mineral of Indian beach placers, has been subjected for geochemical evaluation using the samples collected from various geological environments of south Kerala. The purpose of this study was to investigate the degree of compositional variation in ilmenite grains and also to establish the degree of elemental leaching from this mineral during weathering and transportation. Laterite, sedimentary rocks, alluvial sands, lake bottom sediments and beach placers were sampled systematically to separate ilmenite crops. Major elements data from over thirty samples indicate that FeO varies from 8 to 37% and Fe_2O_3 from 9 to 344% with a corresponding variation in TiO_2 content. Trace element analysis in ilmenite has proved that there are four groups of elements, which represent highly migrating, moderately migrating, weakly migrating and lastly non-migrating types. Ilmenite grains from the beach placers show more or less uniform trend of base level concentration of all trace elements with a more constant value for the element zinc.

A NEED FOR RETHINKING IN THE APPLICATION OF MINERAL ASSEMBLAGES TO PROVENANCE

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Provenance is defined as the job of determining source rock for the final fractionated residue or sediment and to deduce from the maturity of the same, the nature of the climate and relief of the source area. Presence of fragments from distinct rock or an unusual mineral in the sands may lead to such effort more certain. In the case of compact, well settled paleo sediments, it may be possible to point out the nature of provenance from the definite number of minerals recognised. However, in the case of the present day beach or river, where active sedimentation is going on and day to day the nature and supply of sediments are changing, the concept applied to paleo sediments is not found useful to derive the provenance.

While, taking Tamil Nadu beaches and rivers as a type case, one finds a distribution of 102 different kinds of minerals so far recognised from the different catchment zones. But, from the existing results brought out from the beach and rivers, only 30 minerals could be recognised. It is rather difficult to ascribe the loss of rest of the 70 minerals to the cause of erosion, leaching and other means of destruction. Effort has not been made sufficiently to locate those 70 minerals and the processes leading to loss of those minerals.

When one considers those 30 minerals, it is perplexing to locate these minerals in the areas where they do not find a place in the hinterland. For example, glaucophane, the predominant mineral in the Mandapam to Kanyakumari beaches, where does not find a place in the hinterland gneisses and granulitic rocks.

Similarly, in the case of the mineral assemblage of a river and beach, one finds a drastic change in the nature of mineral segregation. In the Vellar river where there is no topaz and epidote, they are found in the respective Parangipettai beach that too, appreciably. Moreover, when the size and shape

of the grains examined for zircon, kyanite, garnet, etc., the roundness index and the angularity ratio do not match with the sands in the downstream and beach. The overgrowth and outgrowth available in zircon do not permit to attribute the hinterlands for the provenance.

When the individual minerals are chemically analysed, the composition wise they do not match with the results available in the respective hinterland minerals from the catchment rocks. For example, magnetite and ilmenite are analysed in the beaches as well as from the charnockite and gabbro of this region, the Mn/Mg ratio in the beach magnetite and ilmenite identifies to the source of basic rock, which is not prevalent in the Tamil Nadu catchment zone.

In view of such irregularities noticed in the distribution of minerals in the beaches and rivers, the sedimentalogist who is studying the provenance has to necessarily account the causes of such contradictory distribution. It may be attributable to the role of coastal and fluvial dynamics on the recent sediments. A better look on these aspects with recent sediments by taking different catchment zones in detail may help to revise the interpretation taken on the ancient deposits of this region.

DISTRIBUTION OF HEAVY MINERALS IN THE QUATERNARY SEDIMENTS AROUND VELLAR BASIN, PARANGIPETTAI, TAMIL NADU

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About 60 samples were collected in and around Parangipettai from different kinds of Quaternary formations. They have been analysed for the presence of heavy minerals. The mineral assemblage indicates the predominant presence of minerals like actinolite, biotite, chlorite, garnet, glaucophane, hornblende, opaque, rutile and zircon. The distribution of heavy mineral by weight percentage records a depletion in the vicinity of Vellar mouth region (2.5 - 7.9 %) whereas away from the Vellar river particularly in northern direction a sudden rise in the distribution of heavy mineral to the tune of 25 % by weight is noticed.Taking with account the existing oceanographic parameters like waves, currents and tides, it is ascribed to the prevalence of northerly moving littoral currents.

There are three rows of beach ridges in the respective swales. The heavy mineral concentration in these beach ridges shows a variation from 3 to 36 %. Here the same beach ridge is found to have a higher concentration of heavy mineral in the northern extent of the beach ridge when compared to limb of the ridge close to river as well as the extension of same in the south of river which is seen adjacent to the Vellar river. All these beach ridges indicate such variation linearly. Once again it substantiates, probably, the prevalence of the present type of sediment movement in the Holocene period too. Likewise, the cheniers are checked for the heavy mineral concentration. These show a very less presence of heavy minerals in the range from 2 to 14 %. The reduction in the percentage of heavy mineral even in the north affirms the lack of heavy mineral supply in the fluvial condition as well as the addition of more light fraction under aeolian environment.

The mineral assemblage whether it is north or south has shown an appreciable percentage of overgrown and outgrown zircon. The presence of such recycled grains enable the possibility of the deviation of these heavy minerals

appreciably from the Cretaceous-Tertiary sediments noticed widespread in the catchment of Vellar river.

The Q-Mode factor analysis was carried out to reaffirm statistically the source of sediments. It has also confirmed the earlier interpretation of heavy minerals deposition by the process of selective sorting primarily by means of re-working of paleo sediments.

A PRELIMINARY STUDY OF PLACER MINERALS IN GADILAM RIVER BASIN, TAMIL NADU, SOUTH INDIA

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The Gadilam river basin from part of Southern Peninsula, Tamil Nadu, India. It extends an area of 1394 Sq.Km. The Gadilam river emerges from the foot of Kalvarayan hills and comprises parts of Villupuram and Cuddalore districts. The Charnockite, Leptynites and schists and gneisses of Archean complex constitute the major rock types in the upstream area. The younger cretaceous and tertiary formations form the midstream and recent alluvium in the down stream parts of Gadilam basin. It is bounded by the Ponnaiyar basin in the North and Vellar basin in the south. The apex of the Gadilam river course starts from Rishivandiyam and it bulges out at Thirukkoilur and Ulundurpettai area. Once again it shrinks near Thirunamanallar, and once again it bulges towards south near Neyveli and Kurinjipadi area because of Perumal Eri and Uppanar river. It's major distribution is mainly near Panruti, Cuddalore, Nellikuppam and Kurinjipadi. The preliminary study of the alluvial deposits of Gadilam river basin reveals a coarse grained nature in the upstream fine grained mixtures in midstream area. About six samples in two cross section near Panruti across the river were collected and the percentage of Magnetic heavies are estimated in three size ranges (0.5 to 0.25 mm,0.25 to 0.125 mm and 0.125 to 0.0625 mm). The heavy mineral concentration and their identification of heavies and light were carried out. The following minerals were identified in the light fraction of the samples. They are quartz, potash feldspar and plagioclase feldspar. Heavies are chiefly composed of magnetite, ilmenite, hypersthene,hornblende, chlorite, zircon, rutile, glaucophane and tourmaline. It is found that the magnetic heavies concentration increases with decrease of grain size, particularly in the 0.125 to 0.0625 mm size range a minimum of 1.5 % to a maximum of 15.5 % is observed. The result of the preliminary study suggests a detailed exploration of placer heavy concentration zone in the Gadilam river basin.

THEME VII

GOVERNMENT POLICIES, LEGAL ASPECTS AND INDUSTRIAL INTERACTIONS

INDIAN SCENARIO ON BEACH PLACER STUDIES IN INDIA

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In India, there are two major groups are working on beach placers, while one is of Government Organisations like Atomic Mineral Division, Geological Survey of India and Mineral Exploration Corporation Limited and the other group is of autonomous bodies like Universities and other Academic Institutions.

Over all, since the year 1914, the published works on placer deposits are found to be around 119. More than 50 to 75 unpublished reports are also available in this regard.

The studies on placers in India mainly dealing the major aspects of exploration of heavy minerals, placer forming processes and provenance. Few papers, that too, in single digit are dealing the environmental impact on coastal mining as well as processing and mining technology. Based on this study, almost 1,566.40 km of beach sector had been explored and the probable estimated reserves are in the tune of 184.74 MT except offshore.

This review has enabled to identify future thrust areas in the field of research and development on placers. They are as follows:

1) The role of landward migration of sediments, that too in enriching the coastal placers.

2) Opaque minerals' chemical and optical properties have not been properly studied to interpret the provenance of placers. Basic research on these lines have to be strengthened.

3) To study the role of coastal tectonics and its influence on the placer segregation.

4) Work on buried placers, tracking the paleo channels both on land and offshore have to be given priority.

5) Placer exploration making use of remote sensing and geophysical techniques have to be popularised.

6) Very little research is seen in the fields of beneficiation of low grade placers and developing a suitable mining techniques to suit our coast. The emphasis here should be minimising environmental damage due to mining and processing.

7) The studies on impact of mining on the environment and methods for re-estabilising the coast to the pre mining state, has to be given importance immediately. An integrated programme with involvement of economists of this country has to be promoted with the objective of sustainable development.

DEMAND FORECASTING MODELS FOR GARNET AND ILMENITE: AN ECONOMETRIC APPROACH

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The Economic growth of India revolves around the agricultural and industrial sectors. At present India expects a grater rate of growth for solving its perennial problems of unemployment and poverty. This can be best accomplished by faster industrial growth comprising largely mining and manufacturing sectors. However, the manufacturing sector contributes more for the industrial growth and grows at the rate of 10% , whereas the mining sector grows only at 3 % at present. Therefore, there is an urgent need to increase the production of minerals in this country both for domestic consumption and exports. This necessitates econometric model building for forecasting the demand estimates inorder to sensitise and enthuse the industrialists to invest in this field.

This study attempts to construct demand forecasting models for garnet and ilmenite, the minerals presently allowed even for private sector. The study employes trend, growth rate and regression analyses for projecting the demand upto 2010 A.D.

The results show that the prices and exports are the most determining factors of demand for garnet and ilmenite. Therefore, the concerned government agency has to take necessary efforts for price stabilisation and export promotion.

KEY NOTE ADDRESS

KEY NOTE ADDRESS

PLACER MINERAL DEPOSITS - NEED FOR A PRAGMATIC APPROACH

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Transworld Garnet India Pvt.Ltd., Chennai.

The occurrence of heavy mineral sands along the East and West coasts of India have been engaging the attention of a number of both domestic and foreign investors in the recent years, especially for their ilmenite and garnet contents in the present scenario. Eventhough, India has a coastline of about 7,000 km, the workable deposits of beach placers have been identified in certain locales only in Orissa, Andhra Pradesh, Tamilnadu on the east coast and Kerala in the west due to a combination of several contributing factors. The placer (heavy) mineral deposits are "**unique**" due to several factors such as assemblages of minerals in free form, natural grading due to actions of ocean currents and wind with their magnetic properties and conductivity lending for less expensive and perfect separation. The beach placers contain almandine garnet, which is best suited for the abrasive industry and hence called a "**rare mineral**". The demand for garnet in abrasive jet cutting applications in the world is growing because of its optimum demand, much desired efforts and posing no health hazards.

The total geological reserves of all the heavy minerals like ilmenite, garnet, rutile, zircon, sillimanite and monazite are estimated to be about 360 million tonnes, constituting about 20 % of the world reserves. The available reserves of ilmenite and garnet are estimated to be about 143 and 44 million tonnes, of which, the bulk are in beach placers, alluvial deposits and inland dunes.

The present production of ilmenite is around 300,000 tonnes per annum, while, that of garnet is around 75,000-80,000 tonnes per annum, the latter constituting about 40 % of the world production / demand. Since, the consumption of the garnet in the domestic market is only about 10 % of our production, the bulk of it finds export markets. The expansion of existing

units for processing garnet and the recovery of garnet as a by-product during the ilmenite production are likely to double the potential during the next 3/4 years. With low domestic demand and increased demand for almandine garnet in the world, the export potential is fairly large and it will not long before India could dominate the world garnet scene.

Mineral deposits **occur in locations dictated by nature**. Mining is a vital necessity for economic and industrial growth. There should be a balance between the mining activities and the environmental safeguards. Undue emphasis on the environmental regulations and standards should not hamper the mining industry. Equally, it should be the endeavour of the mining industry too to develop environment friendly mine designs pertinent to the deposits/ areas depending upon its sensitiveness. There should not be any conflict of interests.

The restriction on the extent of 5 hectares for securing the environmental clearance needs a relook in the interests of mineral development. Likewise, the total prohibition for mining in the area of 200 metres from the high tide level under **CRZ III** classified as **'No development zone'** may be judiciously applied taking into consideration the ground realities, which varies from one state to the other.

It is suggested that the Ministry of Environment and Forests (MoEF) may delineate environmentally less fragile areas where mining activities can be allowed in consultation with the state agencies and AMD so as to avoid wasteful pre-investment studies of the entrepreneurs. The vast resources of the placer minerals have to be converted into workable reserves fit for domestic industries and exports. Both public sector and private sector industries should co-exist to tap the vast potential. A unified approach of both central and state agencies concerned is needed in granting the statutory clearances within a defined time frame to give a thrust to the exploitation of the placer deposits in the new millennium.

FELICITATION ADDRESS

WHY THE LEGISLATIONS IN RESPECT OF PLACER DEPOSITS TO BE AMENDED

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The Most Respected Chairman and other dignitaries, At the outset, let me give my salutation to all present here. Really, I feel proud of participation in this function - "International Seminar on Placer Deposit" organized by Department of Earth Sciences - Tamil University - Thanjavur.

Professor G.Victor Rajamanickam, in all his goodness asked me to attend this meeting. I am not good at speech making. He is not ready to spare me. So, I am here before you.

As one who is associated with placer deposit, in terms of holding mining lease for collection of placer deposit, I would like to present problems associated with getting lease for placer deposit. The exposition is from experience.

As far as grant of mining lease is concerned, it is governed by acts like MMRD act, Mineral Concession Rules, etc., and the monitoring department is Ministry of Steel and Mines in Government of India and Department of Geology and Mining in State Government. Our placer deposit - beach minerals like ilmenite, zircon, rutile, brown ilmenite and monazite are classified as "prescribed substances" and hence Department of Atomic Energy through its Atomic Minerals Division is brought in the picture to give NOC to the prospective applicants of mining lease.

My experience in the Department of Atomic Energy so far is good. Whenever, we ask for NOC in connection with garnet mining we get it promptly. Presently, there is one procedural hurdle faced by the garnet (placer deposit) mining lease applicants. In the case of Poromboke land, the Department needs NOC first from State Government enclosed along with

the application. When we approach the State Government with this proposal, the State Goverment has informed us that they would process the paper only after NOC from the Department of Atmonic Energy is obtained. At the end of the day, it becomes - which came first Chicken or Egg Syndrome. In the scheme of things - the State Government is dedicated with the power of granting mining lease according to the act play down by the substances. However, the State Government is in position to grant or refuse mining lease, no matter the applicant is holding NOC from the Department or not. NOC from the Department is one of the factors that goes into the determination of mining lease. So, the logic of simplification of procedure demands that the Department of Atomic Energy Division grants the NOC without insisting upon the NOC from State Government first and revert back to the earlier practice of granting NOC from the Department first.

Secondly, "Environment" - Development and Environment are both complimentary and supplementary - should be considered as both sides of the same coin. One cannot be divorced from the other. You would all recall that, at the recently held Millenium Round at Seattle - the developing countries demonstrated the determination not to walk into the trap laid hidden by the developed countries in the name of "environment and labour standard". But, at the home front, we face some dichotomy. The ministry of mines and its technical wing Indian Bureau of Mines stipulate that mining plan should be submitted and it is one of the condition for consideration of grant of mining lease. The mining plan should give in detail the Environmental Impact Assessment and Environmental Management Plan. Of course, Indian Bureau of Mines is a technical body well equipped for this, they approve the mining plan after detail consideration of the EIA and EMP. But, in practice this has to go once again to Ministry of Environment for the clearence. It is near duplication and sheer waste of time. The Ministry of Environment in their show of one upmanship makes things in difficult - next, to impossible in getting clearence.

In this connection - a brief narration of operation of beach mineral mining in the coastal area as practiced would be in the right context. The concentration of garnet rich beach placers occurs upto a depth ranging from 5 cm to 30 cm. This thickness ot the garnet and other heavy mineral bearing sands varies from 5 cm to 30 cm. This beach deposit containing garnet is

collected by manpower using shovels, spades and baskets without involving any beaches, slopes or angle upto depths ranging from 5 cm (min) to 20 cm (max). As the layers of garnet deposited by the waves are so removed, the places get refilled repeatedly by the waves. There would be no need to dig deeper than what one can manually scoop out with a spade. So, the coastal stretch would never get deepened to any perceptible levels below the surface. If the heavy minerals thus deposited by the waves is not removed and collected within a permissible time frame, it is likely to be gradually taken back into the sea, by the waves which beat the coast non - stop. In a way, garnet and other heavy minerals, as fine sands are continuously ejected out from the sea by the waves, as rejects, collection of these would be beneficial and non collection would be a loss. The heavy mineral thus collected manually are heaped and transported by the lorries to the separation plants situated 16-20 km away from the coast.

In this kind of garnet mining operation, no drilling, no heavy earth moving, no blasting with explosive, etc., are involved. No sophisticated machinaries are used. They are manually scrapped and scooped with spades and shovels and it is as easy as agricultural activity. One wonders, as to whether it should be called as "mining", in its strictest sense of the term. Because, heavy minerals are classified as a major mineral the term "mining" is used in mineral administration.

Heavy minerals - for that matter - placer deposit containing ilmenite, zircon, rutile are classified as major mineral. It is fine. But, the collection of this placer deposit is so simple an operation similar to agricultural activities - in fact it has no environment impact at all. But, in the name of major mineral - the collection of placer deposits is subjected to procedures, sanctions and clearance from Department when there was no case at all. This fear is also addressed to and taken care in the EIA and EMP.

The applications for mining licenses are shuttled years during District level and State Government Office. Because, no time frame in law for dispose of the application. So, once applications were made and they were not disposed of within six months period the concerned applicant may be permitted to start mining operation as deemed grant in respect of patta lands. Let me take the liberty of citing a case. In the Panchayat act, once one person

filed application for getting building approval and if the concerned Panchayat authorities did not make objection within 60 days, even though they did not give approval for that application, it may be taken as deemed approval under the provisions of Panchayat act.

It is in line - let me say that in keeping with the latest thinking on good Governments and effective Governments.

The nature is bountiful enough to bless mother India with natural resources in the form of placer deposits along our coastal area. The Government policy on beach mineral is a realization that we should make best use of our natural resources available in the way of placer deposit. Our bold reform programme includes, allowing the private industries to explore and exploit this mineral. It is a welcome step. If we want to reap the full benefit out of this policy, the procedure for getting mining lease for placer deposit should also be reformed, simplified - made entrepreneurs friendly, by freeing it from the suffocating procedure of getting clearance from the Environmental Ministry.

I take this oppurtunity to cite once again that in the matter of granting license for placer deposits. Since, it is simple operation and does not recover any so called hi-technology and the deadly dollar - we need not learn the art of collecting the placer deposit with shovel and spade from any foreigner and we can do it better by ourself - the Governemnt of India should adopted policy of granting lease to individual firms and companies who are citizens of India by giving preference over the foreign national or to the companies owned by foreign nationals.

I strongly believe that this forum would champion this cause and cause action for solution.

I congratulate once again, the Department of Earth Sciences in particular Professor G.Victor Rajamanickam and all other connected with this seminar for organizing this first ever seminar - International seminar on placer deposit and wish this seminar a grand success.

With these words let me take leave of you by once again conveying my namescaram to one and all of here.

A CASE STUDY OF THE PLACER MINERAL DEPOSIT OF UVARI TIRUNELVELI DISTRICT, TAMILNADU

R.Srinivasan, K.Nandagopal and M.P.Saravanan

Transworld Garnet India Pvt. Ltd., Chennai.

The heavy mineral deposits occurring in K.Uvari village about 44 km, southwest to Tiruchendur in Tirunelveli district, Tamilnadu is a promising deposit, earlier examined by the Atomic Minerals Division. Transworld Garnet India Pvt. Ltd., has set up a 100 % export oriented unit and has acquired private lands containing heavy minerals deposits and secured the mining leases. The reserves are captive for the processing unit set up near Tuticorin with an installed capacity of 60,000 tonnes of garnet products per annum.

The deposit stretches for about 3 km in length, with widths ranging from 180 to 200 metres. The garnet bearing lands lie about 70-120 metres from the HTL of Gulf of Mannar.

At the instance of Transworld Garnet, AMD have carried out the drilling work in the mining properties. Apart from AMD's work, the Company also undertook detailed exploration. The detailed exploration followed by mining and the feed back on the processing of the sands from our Mill have yielded plenty of data on the nature of the deposits as a whole and the characteristics of the individual minerals.

The beach sand contains about 38-40 % of garnet and 1-2 % of ilmenite. The bulk of the garnet produced (70-75 %) is of +20 to +60, while the fine grades (-60 to -120) constitute 20-25 %. Silica is associated with the coarse grains of garnet and is totally absent in the fine mesh sizes, where the ilmenite shows its presence. The studies on the characteristics of the mineral assemblages have helped the Company to redefine the processing techniques from time to time to secure maximum recovery in the processing Mill at Tuticorin.

The qualities of almandine garnet and its industrial uses are discussed in the paper.

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